THE MAGAZINE OF VISUAL COMPUTING

NUMBER THIRTY-FOUR/4 95

IRIS

u n i v e r s e

BREAKTHROUGH:

VISUAL COMPUTING AND THE REINVENTION OF BUSINESS

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WINTER, 1996

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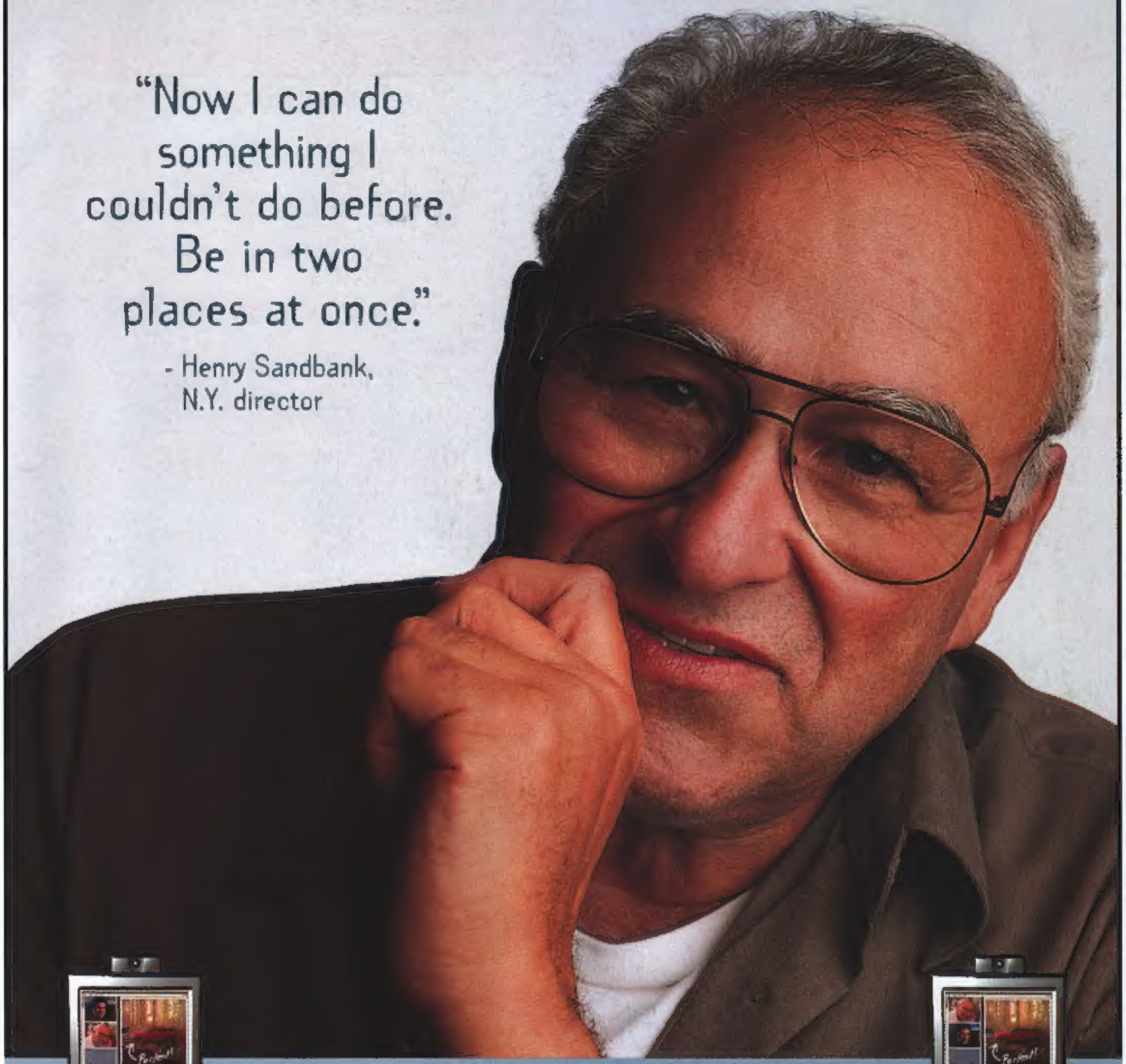

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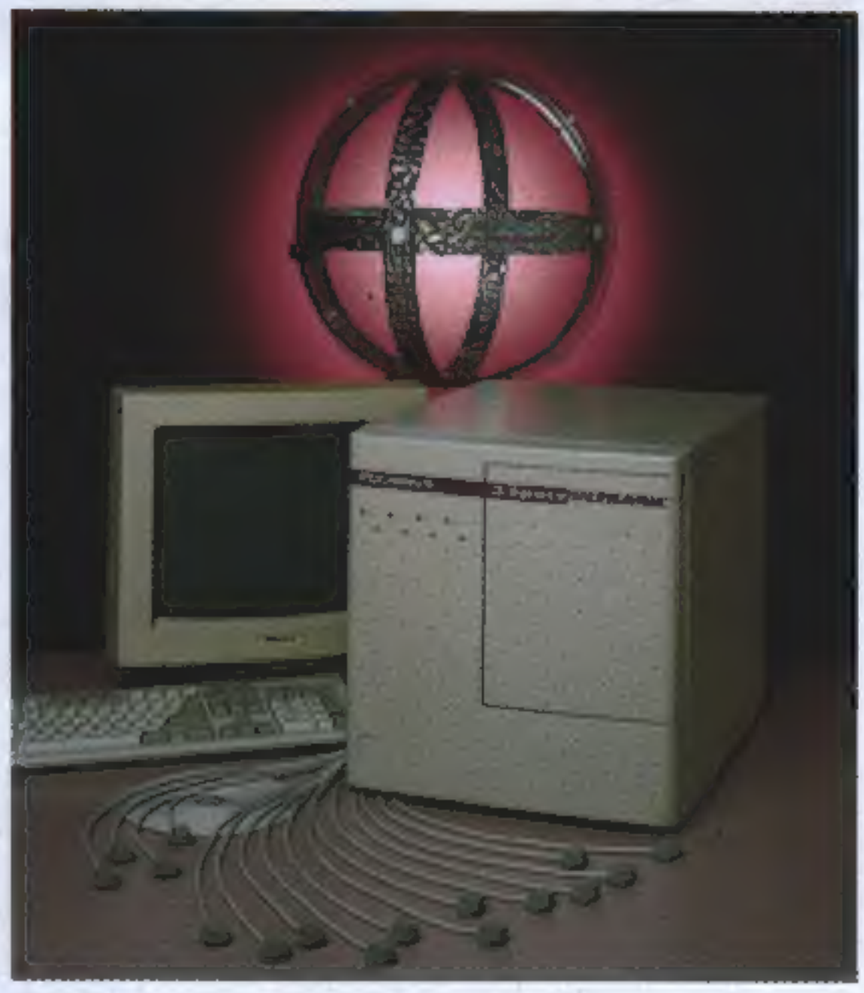

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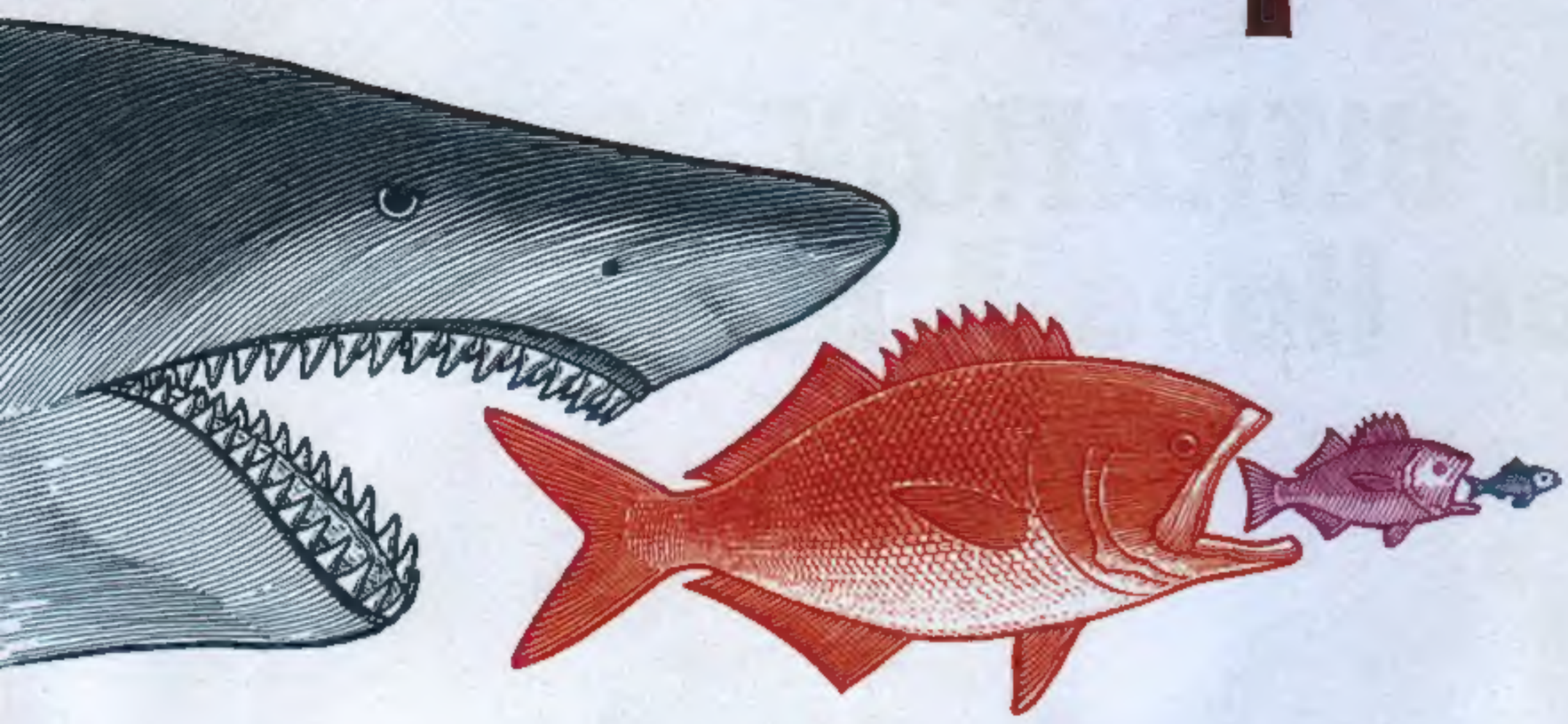

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THE MAGAZINE OF VISUAL COMPUTING

NUMBER THIRTY-FOUR

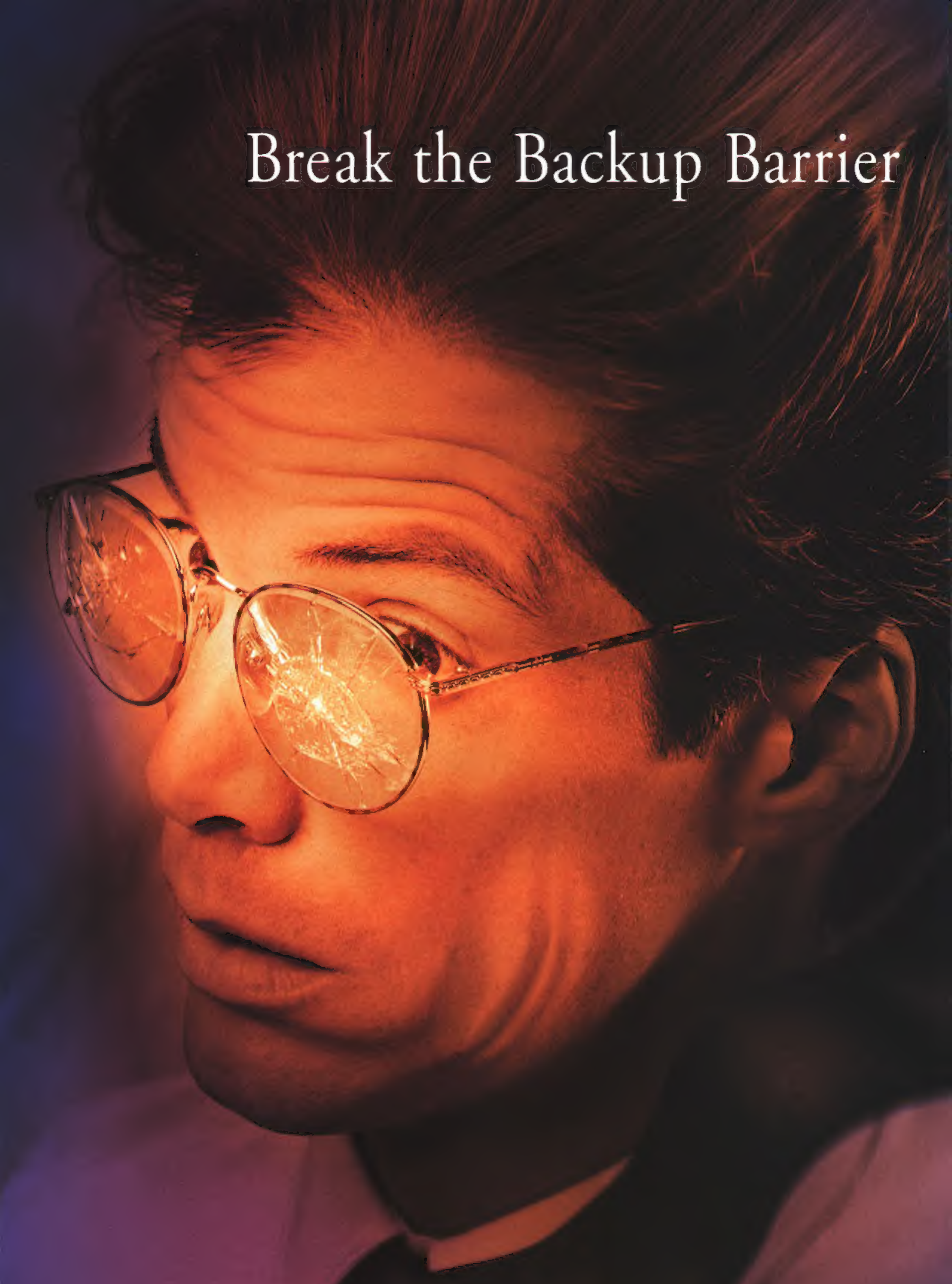

P.32


P.40

ON THE COVER: Michael Wills, manager of technical marketing for corporate communications at Silicon Graphics, created this image using software from Alias/Wavefront and SoftImage. Michael has twelve years experience in computer graphics, including six years as an animator at San Francisco Production Group and Vertigo Technologies. In addition to gracing the cover of this issue, Michael's image serves as a captivating screen-saver for the machines installed in Silicon Graphics Corporate Briefing Center in Mountain View, California.

DEPARTMENTS

Break the Backup Barrier



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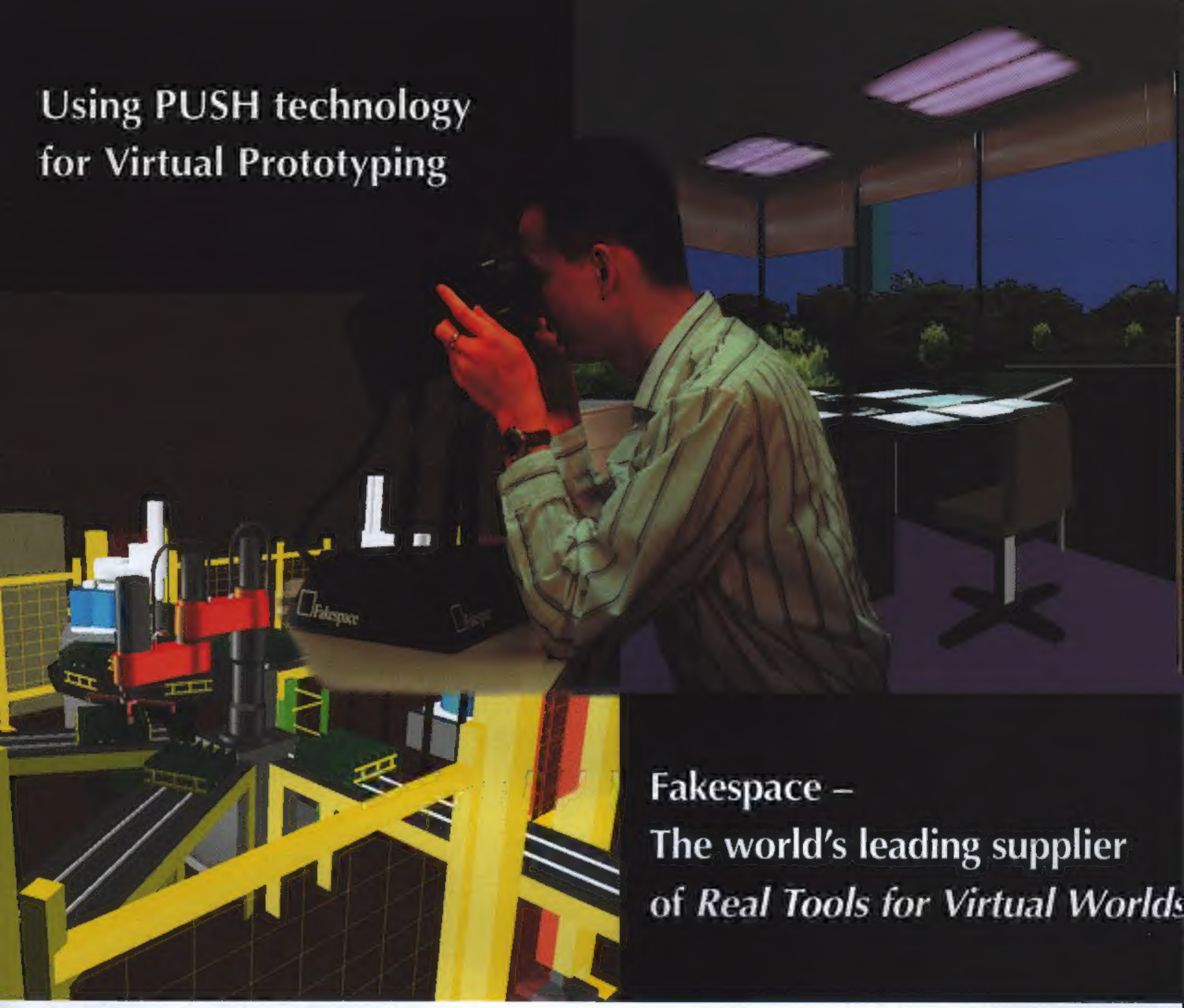

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Disappearing Act

Odd as it may sound coming from a company like Silicon Graphics, one of our goals has always been to make computers disappear. In other words, to make their use so easy, their functioning so quick and transparent, that the users all but forget they're working at computers. We haven't entirely succeeded yet, but we will—perhaps sooner than many suspect.

Technology that we were merely dreaming about a few years ago is now part of our product line (at a far lower cost than we once thought possible). And the astonishing popularity of the World Wide Web has underscored the power and significance of visual computing. Indeed, the very words "visual computing" seem to be cropping up everywhere these days.

This issue reflects the fact that visual computing, visual computing networks and other new information technologies have become a permanent fixture in the lives of people almost everywhere. Those who are relatively new to visual computing, as well as some of the veterans, will enjoy reading *The Inevitable Engine* and *Seeing the Possibilities of Working Visually.*

These two articles kick off a new series that we'll be running over the next several issues. Elsewhere, in a wide-ranging interview, Ed McCracken, CEO of Silicon Graphics, talks about the Web, his mentors, and even his reading habits among other things. Also, *Internet Cafes* covers the new trend that is making technology a central part of out-of-the-home socializing. And *i on Visual Computing: Documenting a Revolution* discusses the exciting new Web magazine that is already a paragon of on-line richness, vitality, and informational elegance.

As computing technology increases in sophistication, power, and ease-of-use, it is, in a sense, disappearing and, as demonstrated in this issue, people and ideas are taking center stage. Go ahead, call us odd, but that's the way we've always thought it should be. Haven't you?

Carl Furry, Executive Editor, *IRIS Universe*

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From the Silicon Graphics Corporate Briefing Center

Located in the heart of the Silicon Graphics campus in Mountain View, Calif., the Corporate Briefing Center is a magnet for visionaries and technology seekers. The Center showcases the latest Silicon Graphics hardware and software, as well as software, from partners and other vendors, that runs on Silicon Graphics platforms.

Last year over 15,000 people toured the Center including a diverse list of celebrities interested in visual computing, from Michael Jackson and The Grateful Dead to President Clinton and the Sultan of Brunei.

IRIS Universe takes you inside the Center with this sampling of images that are part of a typical tour.

1) Eric Jue of Silicon Graphics used Alias software to create this logo for the Business Development/Corporate Briefing Center home page.

2) The Silicon Graphics Corporate Briefing Center at corporate headquarters in Mountain View, Calif.

3) This still, from the annual DevForum '95 film festival, was created with Wavefront software on an Indigo² workstation for design and on an Onyx for compositing. Rick McKee of Silicon Graphics served as technical/art director on the project with animation by Guzmo Gypsies.

4) Michael Wills used Wavefront and SoftImage software on Silicon Graphics Indigo² and Onyx hardware to create this image for the opening animation for the Entertainment Authoring Conference 1995.

5) Rick McKee ran SoftImage software on a Silicon Graphics Indigo workstation to create this image, part of an animated opening sequence for San Francisco Production Group.

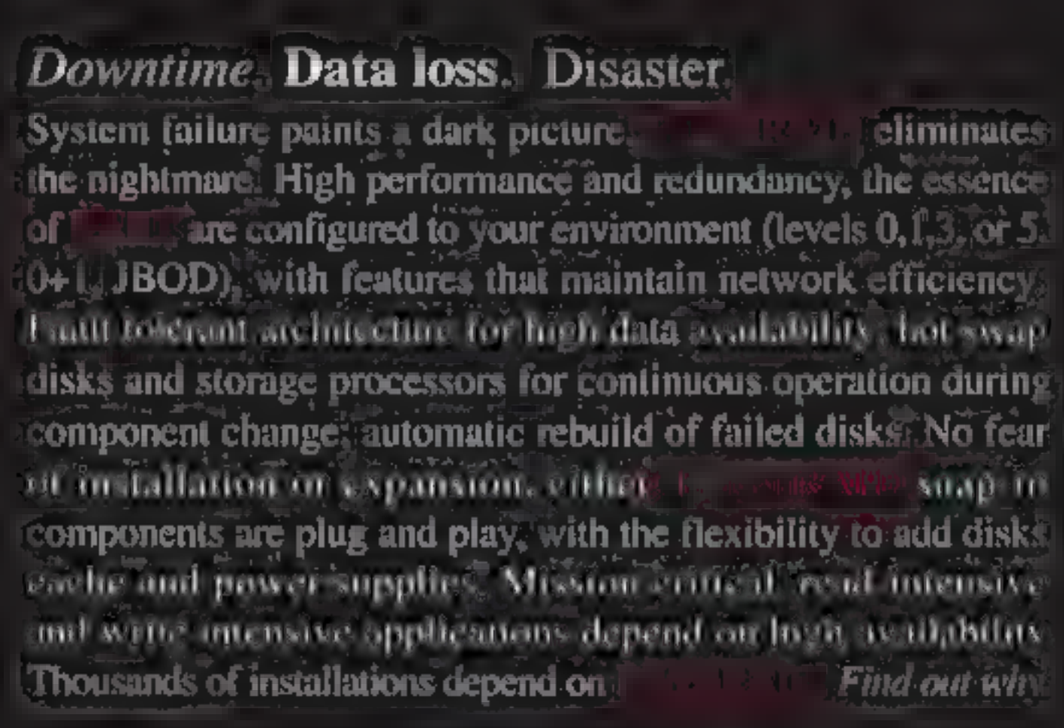
6) Rick McKee used Wavefront and SoftImage on Silicon Graphics Indigo² and Onyx hardware to create this image, taken from the opening animation for the 1995 Entertainment Authoring Conference.

7) This image of the IRIS Indigo Elan workstation was created by Michael Wills.

6

7

system failure looks like this:



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Breakthrough:

Visual Computing and the Reinvention of Business

Silicon Graphics is proud to launch a new series of articles that explore the past, present and future of visual computing and visual computing networks.

It's not news that visual computing and visual computing networks are bringing fundamental change to the way people work. However, in many cases this change is occurring more widely and rapidly than even experts predicted. Indeed, today many executives find themselves presiding over an exciting, dramatic transformation in their organizations, even as they seek to better understand the effect that visual computing is having on their companies and the business world at large.

At Silicon Graphics we're asked all manner of questions—some basic, others complex—about this new technology. In an effort to answer many of those questions and explain what visual computing is, where it came from and how it is affecting business and industry, we present a new series of articles called "Serious Fun: Visual Computing and the Reinvention of Business." These articles will appear in installments in the next four issues of *IRIS Universe*, beginning with the two articles that follow. They will also be published concurrently on the World Wide Web as a feature of the Silicon Graphics online magazine, *i on Visual Computing* (http://www.ion.sgi.com/).

The series will cover nearly all aspects of visual computing—from the elementary and the general to the advanced and the specific. These first two articles give a brief overview of the developments that led to visual computing, and look at ways in which it is now used to gain competitive advantage. In later installments, readers will learn specifically how visual computing is applied in manufacturing, medicine, entertainment, finance, engineering, and countless other technical, scientific, and creative disciplines. Throughout the series emphasis will be placed on addressing the practical concerns of business. Visual computing networks, collaborative computing, and, of course, the Internet and World Wide Web will also be covered.

It's our intention that this series be relevant to the broadest spectrum of visual computing users—from the novice to those who've been benefiting from this technology for a decade or more. (Please let us know if there are particular issues or topics you'd like to see addressed in the series.) Some articles will appeal to one group more than another, but as a whole, we believe that this collection will make a significant contribution toward increasing the understanding of visual computing, its applications, and its potential.

Carl Furry, Executive Editor, IRIS Universe

Wendy Govier, Editor-in Chief, *i On Visual Computing*

The Inevitable Engine

The Evolution of Visual Computing

By Douglas Cruickshank

"The ultimate impact of visual computing will eventually match or exceed the tremendous societal changes already wrought by computers.... Visually oriented computers, computers with a window, open up a whole new kind of communication between man and machine. There are many applications that cannot be contemplated without a visual interface, and the visual interface makes many complex applications accessible to non-specialists for the first time. The future seems filled with potential."

Richard Mark Friedhoff
Visualization: The Second Computer Revolution, 1989

The computer was inevitable. Whether you place its beginnings in the sixth century when the abacus originated in China; in the 1600s when John Napier developed logarithms and Blaise Pascal built the first calculating machine; or later still in the 19th century when Charles Babbage conceived of his Difference and Analytical Engines, the computer had to happen. It would have been more surprising if it was not invented. In any case, the concept for such a device has been evolving for centuries.

In Pamela McCorduck's book *The Universal Machine: Confessions of a Technological Optimist*, she refers to the computer as an "...inevitable engine for the Age of Symbols," alluding to its singular ability to "symbolize," or model, a typewritten page, a three-dimensional object, or even the movement of such an object through space. As she expands on her description, McCorduck extols the computer as a human machine in a way no other has ever been... "for it liberates and magnifies the human property that has always served us best, our own intelligence."

A computer cannot think, of course, but, as McCorduck points out, it can do an outstanding job of amplifying the processes of the human brain, an organ that by nature seeks to extend and replicate its own characteristics, the world around it, and the defining components of that world. The capabilities of the computer—especially the immense power and vast database employed in visual computing—facilitate these very human aspirations by providing a medium in which virtually all aspects of reality can be precisely and convincingly simulated. This allows extraordinary creativity while increasing efficiency and minimizing the risks and expenses often inherent in experimentation, problem analysis, testing, and creation of prototypes. In turn, these qualities make practical abundant applications in industry, science, and business. The result is that visual computing is today changing the very fabric of work, even redefining it. A brief look at how visual computing has evolved may help put this change into context.

Beginnings

Not surprisingly, much of the early work that led to the development of electronic computers in the middle of this century was related to defense and cryptography, specifically the creating and breaking of military codes. Perhaps the most important and dramatic among the several efforts in progress in the late 1930s and early 1940s was the work done by the brilliant English scientist Alan Turing. It was Turing who, during World War II, was principally responsible for inventing the machine that broke the "unbreakable" German secret code known as "Enigma."

"As he observed the work of his machine," explains an introduction to Andrew Hodges, excellent 1983 biography of the scientist, "Turing became increasingly challenged by the possibility of using the new techniques of electronics to translate symbolic mathematical logic into reality..." Turing's work was highly influential, but, as it happened, it was others, in the United States, who took the next crucial steps in the development of the modern computer.

In the mid-1940s, ENIAC (Electronic Numerical Integrator and Calculator), the first electronic digital computer, was built at the University of Pennsylvania. A digital computer processes information that has been encoded digitally, which means that regardless of what type of data the system is processing the information is represented by a code of numbers (in the case of ENIAC these numbers were decimal rather than binary). An analog computer, on the other hand, processes constantly variable data—for example, voltage or currents. Systems that enable visual computing, personal computers, and most computers now in use are digital, employing a binary numbers code.

ENIAC was larger than a two-car garage, extremely slow by current standards (one of today's lowest cost home computers would leave it in the digital dust), and was essentially obsolete by the time it was completed. Nevertheless, the success of ENIAC (it stayed in use until

1955) signaled the beginning of the computer age. The earliest graphics system, the Whirlwind computer, was developed several years later, in 1951, at the Massachusetts Institute of Technology. According to one of its developers, the Whirlwind comprised "about a quarter of an acre of electronics and had about 5,000 tubes in it."

Fortunately, over the intervening decades, computers became considerably smaller, faster, and easier to use. In 1971, the development of the microprocessor—a single, small silicon chip incorporating all the basic capabilities of a computer—made the personal computer possible. And as everyone knows by now, the 1980s brought with them the widespread success of the user-friendly, visually-oriented Apple Macintosh, as well as the IBM PC, and its many successful imitators or "clones." With astonishing swiftness, the computer replaced the typewriter as the machine most likely to be found on the desktop (or on a lap), and by 1995 typewriters were no longer manufactured in the United States.

The Breakthrough

While the personal computer has had a revolutionary effect on how people get their work done, the introduction in the 1980s of computers that could rapidly generate and manipulate two- and three-dimensional graphics is now recognized as a major breakthrough in bringing a more natural and intuitive approach to computing. Some of the most consequential changes in the workplace, and in work itself, have occurred relatively recently—over the last decade—with the proliferation of visual computing delivered by powerful "workstations," such as those made by Silicon Graphics. And it has been only in the last five years or so that the ascent of performance coupled with the descent of computer prices has brought visual computing from a niche technology to the mainstream, making it economically viable—and in many cases essential—for a multiplicity of everyday uses in business, industry, and science.

Beginning with that early, cryptography-related work done before and during World War II, and for the subsequent four-and-a half decades, advances in computing technology were primarily driven by the needs of national defense. Then, in the late 1980s, with the end of the Cold War, a change took place: The requirements of the entertainment industry began to drive the development of technology. Now, propelled by the high-tech demands of entertainment production, enormous strides are being made in visual computing. But the ramifications of these advances are being felt virtually everywhere that computers are used.

Indeed, throughout the world, the use of visual computers is substantially reducing the time it takes companies to get products to market—greatly improving on any reductions realized through conventional computing. It's making research, development, design, and production operations far more efficient, and enhancing creativity. Visual computing is also achieving broad success in medicine, architecture, simulation, multimedia, and emerging fields with new applications, such as data mining.

> The perfection of VLSI made it possible to achieve an extremely dense grouping of components onto an integrated circuit.

Since the advent of modern computing 50 years ago, people have aspired to create computers that allow them to work naturally and intuitively—the way they did before computers existed—but with greater speed, precision and efficiency. Visual computing makes this possible: It facilitates the management of massive amounts of information, features an easy-to-use, intuitive graphical interface, and displays models in realistic three-dimensional forms that can simulate the movement and behavior of objects in the real world (either in real-time, slowed, or accelerated). Visual computing systems also provide users with a visually-oriented environment—a color, 3D window with point-and-click menus and easily recognizable symbolic icons—instead of a monochromatic screen and cryptic keyboard commands. Visual computing also employs sound, yet another sensory cue that helps people to better understand information. This set of features enables the human brain and the computer to collaborate more closely (and comfortably) than ever before.

A Dramatic Acceleration

Edward McCracken, chairman of the board and chief executive officer of Silicon Graphics, credits the invention in the early 1980s of VLSI (very-large-scale integration) techology, such as his company,s Geometry Engine product, with forever changing the way computers are used. The perfection of VLSI made it possible to achieve an extremely dense grouping of components (transistors and other elements) onto an integrated circuit. "That breakthrough technology," McCracken says, "dramatically increased computer graphics performance, enabling a computer screen to repaint itself several times per second. Suddenly, the two-dimensional computer terminal became a window into a three-dimensional,

virtual world where users could manipulate high-quality graphics for greater and quicker insights into complex problems." In other words, the components (or entire systems) of the "virtual world" to which McCracken refers can be viewed, explored, and "handled" in similar fashion to the way an object or process is observed or handled in the real world.

The effectiveness and speed of visual computing depends on its incorporation of other successful technologies, With UNIX as one of the most significant. UNIX is a powerful, general purpose, multiuser, multitasking operating system first developed in 1969 at AT&T Bell Laboratories. The operating system controls a computer's functions and is the means for the user to interact with its microprocessors. The operating system also serves as the foundation upon which applications—from CAD to animation programs—are built. Other well-known operating systems include MS-DOS, Apple's Macintosh operating system and Windows. Especially well-suited to the requirements of visual computing, UNIX allows more than one program to run at the same time, can be readily transported from one computer to another, and satisfies the needs of the software engineers who develop applications.

Visual computing lets design and analysis proceed in parallel, reducing time and money spent on dead-ends

Certain custom implementations of UNIX, for example IRIX, developed by Silicon Graphics, bring together the benefits of advanced technology and industry standards, enabling the parallel processors found in visual computers to deliver maximum system and application performance. Computers using the IRIX operating system commonly combine four key technologies that work together to cope with the extreme technical requirements visual computing imposes on the computers that deliver it. Those four technologies are interactive 3D graphics, symmetric multiprocessing and high-performance system architecture, digital media, and RISC processing (see sidebar).

The Major Advantage

The early computers were a brilliant innovation, helping people work faster, and complete a greater quantity of work. But they did not really provide a more natural, intuitive way for people to interact with a machine. Visual computing does. It also enables greater creative freedom during the development of ideas since variations and modifications can be explored far more quickly, inexpensively, and safely than with physical models. Visual computing lets design and analysis proceed in parallel, reducing time and money spent on dead-ends, and helping high-quality products get to market faster. It also saves time by allowing ideas to be communicated more effectively. And this communication can be interactive, with ideas discussed and modified on line, among a work group, clients and customers, or between technicians and executives located in the same building and connected through a small local area network (LAN), or spread across the globe, communicating via the Internet.

Finally, visual computing generates new ideas by allowing the visual, intuitive datamining of vast amounts of information stored in relational databases or filesystems. By converting this raw data into organized, refined, and useful information (often in an easy-to-understand graphical form), a company can maximize the value of its available data resources.

Such circumstances can produce a valuable ancillary effect, bringing uncommon worth to data not usually thought of as intrinsically visual. For example, consider the difficulty an investment counselor would face trying to explain to a client the interrelationships and constantly shifting values (the bid and asking prices) of the 500 equities making up Standard & Poor's stock index. Most wouldn't even try as it's a nearly impossible task. Yet, a visual computer can take such chaotic data and actually animate it in real time, creating a three-dimensional "information landscape" that not only clearly illustrates the ebb and flow of a large sector of the stock market, but displays the dynamics of the S&P 500 over any given period of time. Using such a system, and with minimal explanation, even the novice quickly grasps the significance of complicated fluctuations in the equity market and individual stocks. Examples such as this one are innumerable; visual computers simplify the complicated and abstract while leaving underlying complexity intact. They make it possible to work with even the most voluminous information on a manageable, human scale.

Visual computing materially alters the way people use computers, but what it really accomplishes is allowing people to work together in much the same fashion as they did in the centuries before computers were introduced—interacting spontaneously. In a November 1994 magazine article, Carl Machover, an author and professor of computer graphics at Rensselaer Polytechnic Institute, wrote: "[visual computing] ...provides a powerful interface between the person and the computer, forcing the computer to talk to people in the language of

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pictures and letting them talk back in the language of gestures. The profound value of this new way of working is in its simplicity: It vastly improves the way people interact with computers and with each other by adapting the functioning of the computer to accommodate the idiosyncrasies of human thinking and perception, rather than forcing humans to adapt to the peculiarities of the computer."

Visual computing is bringing intuitive, interactive computing to all types of work. In so doing it is introducing fundamental (and pervasive) change to all computing. However, while many people today are familiar with visual computing's most publicized applications—special effects for motion pictures and virtual reality—fewer understand its relevance to the work they do. The countless ways in which visual computing is being used and the powerful systems that make it possible will be the focus of this series of articles.

Douglas Cruickshank began his career in radio and later turned to book design and filmmaking. He now writes on technology, travel and other, harder to categorize, subjects for print and on-line magazines, and corporate publications. His weekly column, The Raw and the Cooked, appears in Salon on the World Wide Web. He is the former editor and co-founder of The Fessenden Review. And he is also the former editor of Iris Universe magazine. He has been a restaurant critic for Frisko magazine, a movie critic for the San Francisco Examiner, and an editor at Whole Earth Review.

Cruickshank occasionally writes film and television treatments, and scenarios for virtual environments. In the early 1980s he created and produced the thirteen-part public television series "The Independents," a collection of independently produced documentaries. And while working as an independent filmmaker he produced several films, including the documentary feature, Victory Over The Sun, a recreation of the 1913 Russian Futurist opera. He lives near San Francisco.

What Is Visual Computing?

Visual computing uses the screen as a window in which reality can be mimicked and magnified. The three-dimensional images displayed on the screen are shown in authentic colors and textures, with subtleties of light and shadow. These displayed 3D objects can also move realistically in real time, enabling users to simulate, and often predict, certain characteristics of the real world—both visible and invisible. On screen movement can also be slowed or accelerated. High-quality audio further enhances realism. Networks, whether they connect a half-dozen systems or function on a global scale, allow users to work collaboratively. Visual computing lets users quickly explore, communicate, clarify, and understand complex information by significantly reducing the barriers between people and technology.

The Four Key Technologies of Visual Computing

These technologies are the foundation for the visual computing workstations and servers that are used in today's most complex and demanding applications.

Interactive 3D Graphics

Extremely fast real-time 2D and 3D graphics performance—complex ideas are displayed instantly, with realistic color, shading, textures, and movement. Users can interact with a 3D object in much the same way that they would in the real world.

Symmetric Multiprocessing and High-Performance System Archtecture

Symmetric multiprocessing computers—systems that enable the use of multiple central processing units (CPUs) in one computer—can easily store, move, manipulate, and display the most complex data, whether it is images, video, queries on a large database, or file serving requests. In other words, these systems can perform many tasks concurrently. This design optimizes the performance of single applications, and facilitates simultaneous use of the system for many applications or by multiple users.

Digital Media Capability

The real-time processing of many digital data types, such as 3D graphics, full-frame video, images, animation, audio, and text, which allows ideas to be presented in their most realistic, natural, and easily understood form.

RISC Microprocessors

RISC (reduced instruction set computing) microprocessors are employed in today's fastest, most powerful visual computing systems. The world's leading supplier of RISC microprocessors is MIPS Technologies, Inc., a subsidiary of Silicon Graphics. RISC processors are specifically designed to optimize the performance of real-world applications by concentrating their power on the fast, efficient processing of the small, simple sets of instructions that make up the majority of commands which computers decode and execute. By comparison, CISC (complex instruction set computing) microprocessors, commonly used in personal computers, utilize complex instructions which tend to take longer to decode and execute.

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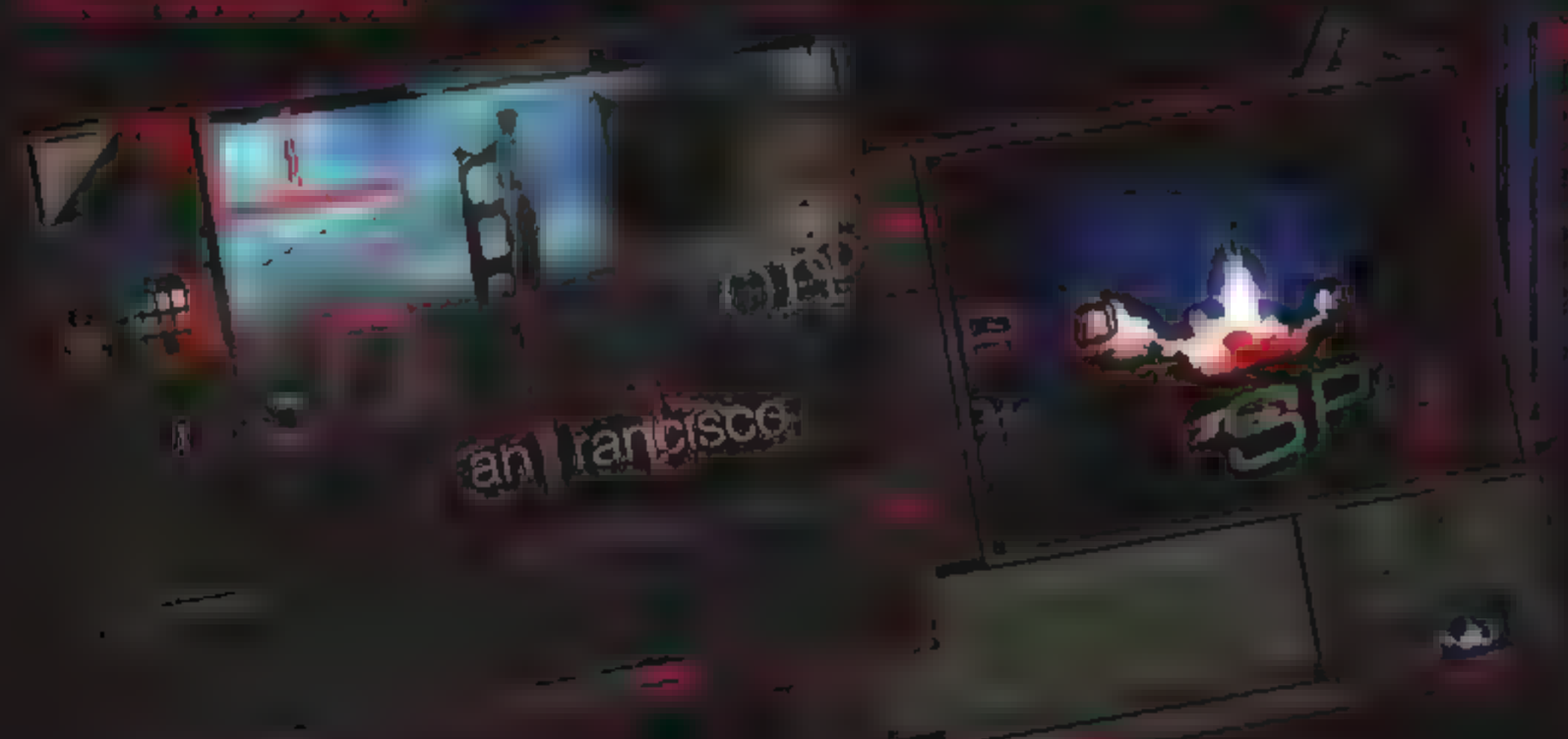

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Ed McCracken

Twelve years ago, he left a sure thing for an exciting young company that seemed risky. Today he's the country's leading evangelist for breakthrough technology. IRIS Universe asks Chairman of the Board and CEO of Silicon Graphics Ed McCracken to reflect on the visual computing revolution—past, present and future.

By Douglas Cruickshank

In 1984, Edward R. McCracken left an upward spiraling management career at Hewlett-Packard to join a little known company that had just recorded a net loss of $6.6 million. Such a move might not appear very shrewd, especially when you learn that the company he joined was a start-up fixated on the odd idea that 3D visual computing would be the next wave in technology. Fortunately, the company was Silicon Graphics—now a $2.2 billion enterprise with revenues predicted to grow substantially in coming years.

What's more, 12 years after Silicon Graphics pioneered its innovative technology, most of its competitors have recently subscribed to the now not-so-odd idea that 3D visual computing is indeed the technology wave that is sweeping the digital world.

Ed McCracken, 51, is chairman of the board and chief executive officer of Silicon Graphics. On a typical day, he drives himself to the company's ever expanding headquarters in a purple Lotus Esprit. The car is a rare expression of flamboyance for the soft-spoken CEO. Reserved and thoughtful, Ed McCracken is the very antithesis of the stereotype hard-charging, fire-breathing chief executive. And yet, for the last eleven years, he's guided his company on an astonishing trajectory toward success after success, not the least of which has been an average annual growth rate of more than 30 percent.

McCracken's office is surprisingly modest for a Silicon Valley CEO. It's tucked in a rear corner on the ground floor of one of the dozens of buildings Silicon Graphics inhabits in Mountain View, Calif. One wall displays a painting by his 24-year-old daughter, Kathi (McCracken and his wife, Sandhya, also have two sons, Tim Bogardus and David). On a shelf over his desk, among other curios—including a small statue of Ganesha, the elephant-headed god who removes all obstacles—

At left: The National Medal of Technology dangles from Ed McCracken's neck as he gets some support at the White House from Silicon Graphics founders. Left to right: Marc Hannah, Tom Davis, Rocky Rhodes, Kurt Akeley, Mark Grossman. Photo courtesy of Lauren Janov.

sit a pair of dice, each face of which depicts a cow with the appropriate number of spots. The dice were sent to him by a colleague visiting Iowa, where McCracken grew up on a farm near the town of Fairfield. The last time he gambled, however, was when he bet on 3D visual computing back in 1984.

Douglas Cruickshank talked with Ed McCracken in mid-October, two days after the CEO had received the National Medal of Technology at the White House.

IRIS Universe: It's been a good month for you—you were named executive of the year by R&D magazine and you received the National Medal of Technology from President Clinton. Why were you given these awards?

Ed McCracken: Our company has been working extremely hard for many years to make three-dimensional visualization a mainstream technology. Now, it's becoming mainstream. And it's talked about in the popular press, which naturally gives Silicon Graphics a great deal of credit for creating this new way for the world to use computers. One of our goals as a company over the last ten years has been to convince the world that the two-dimensional paradigm wouldn't last; that there was going to be a new paradigm, and the computer screen would be a window into a three-dimensional world. Suddenly, more and more people are starting to agree with us, and that's when they start pulling out the awards.

IU: One of the results of having everyone start to agree with the Silicon Graphics vision of computing is that the competitive landscape is now changing dramatically. Hewlett-Packard, Sun, Microsoft, and Intel are all venturing into 3D visual computing. Does this constitute a threat to Silicon Graphics' predominance in the market?

EM: There's always a threat and we've always had competitors. This market is too significant for any one company to control. One of the things we've noticed is that the growth of the market, and our growth, has increased dramatically whenever a major competitor entered this market. This has been true in the cases of Sun, HP, Digital, and also IBM. And I think the same thing will be true of Microsoft. As Microsoft develops a set of bottom-level, PC applications for the 3D visual computing market, I believe we'll find that the market gets bigger still. It's my objective that we'll leverage off this and it will accelerate our company's growth rather than decrease it. Silicon Graphics, however, is interested in the innovative sector of the market—the people who want to do things differently, design things that have never been designed before, and make major breakthroughs. The average person doing simple tasks is not going to buy our products.

IU: You are co-chair of President Clinton's National Information Infrastructure Advisory Council. The council will submit its final report in January 1996. In the two years you've worked with the council, has your view of the information superhighway changed?

EM: Yes, I think it's changed like everybody's has. In the beginning the council viewed the information superhighway in a more general fashion. Much of our emphasis today is on the World Wide Web and the Internet—doing something between now and the year 2000. We've done a lot of good work in the council, such as studying the impact of the Net on intellectual property and privacy, and the need to have the same kind of protection of property rights on the Net as you do when working with paper documents, including encryption. One of the things that's been the most exciting is that we've been able to take this disparate group of people and bring them together in a common agreement that the best way we can kick start this country into the information age is to bring the Internet's World Wide Web into every classroom in our schools by the year 2000. We think we can afford that as a country, and that it's the best thing we can do to prepare the U.S. for the future. We'll be releasing information on that project—called the Kickstart Project—shortly.

IU: How long, in your estimation, before the national information infrastructure—the information superhighway—is fully in place and operational?

EM: I don't think it will be in place and static, as a thing, until at least 2010. However, it will have tremendous impact on society long before the year 2000.

IU: How important is the development of the World Wide Web to Silicon Graphics? And how much of the company's resources are being focused on the Web?

EM: I don't know how many of our resources are being focused on the Web, it's such a bottom-up phenomenon, but I would say a lot. It's one of those things I like to have happen because it's something that very few of us could have predicted three years ago and addressed with a long term plan. Still, by being reactive and tuned-up, we've been able to develop a major business—it now constitutes nearly ten percent of our revenues, and it's growing very, very rapidly.

Our own company is in the process of being transformed, in terms of how we operate and how we work with each other, by how we use the Web. In the beginning it was simply a way to access information, a way to find out, through home pages, what was going on around the company. Now, training information can be accessed on line in a variety of media forms. We provide access to databases. For example, employee benefits forms are available on line. And our corporate purchasing system is going on line. This enables employees to fill-out purchase requests and pass them through the approval loop, all on the Web. There are

a whole set of applications that are changing how we operate within the company.

I think we're further ahead in terms of being a showcase for using the Web inside a company than, perhaps, any other company in the world. We find that when information systems executives—CIOs—from around the world hear about what we're doing they come to visit us just to look over our shoulders and see what's happening at Silicon Graphics.

IU: Do you believe society is becoming stratified along the lines of technology haves and have-nots?

EM: I think there is some stratification. I used to think it was all economic, but I no longer do. I believe it's choice as well. Some people are choosing to be wired and other people are choosing not to be wired, because the model of being wired is not a pleasant one for many people. They have an image of sitting at a computer terminal glassy-eyed, by themselves, relating to other people over the network, rather than touching them and laughing with them. That's an uncomfortable model, and rightly so. I think the real information age society will be both wired and grounded in the real world. We don't have very many models of that yet. As a result many people are rejecting being wired.

However, if we can just get this technology—the World Wide Web—into our schools—give people access to it, give people a chance to play with it, experiment with it, and do homework assignments using it—then I believe it becomes non-religious and non-magical. People will have access to the information and be economically advantaged as a result, but not be disadvantaged socially and in other ways. I think it's very important to our society that we take the religious, magic aspects out of the World Wide Web. Right now it's being sold too much as a religious experience.

IU: Will Silicon Graphics enter the home computer market?

EM: I don't like to make flat statements, because I don't know what we'll do in the year 2000. Right now we know that for the next year we won't, except through designing products for other companies. The best example, of course, is Nintendo and our work on the Ultra 64, which is being announced in Japan in November. It's definitely a home product. Did we design it? Absolutely. So, are we involved in the home market? Yes, it's just that we're not doing the manufacturing and marketing of those products, we're just doing the engineering.

IU: What inspires you?

EM: I've always been inspired by being able to apply technology to real world problems. The way we've done that in the scientific disciplines has been very stimulating to me. Now that we're starting to

The National Medal of Technology

do that in non-scientific disciplines it's even more stimulating. One of the things that inspires me around here is working with phenomenally talented people who are always doing new things, working on new ideas—people testing what can be done with new technologies.

IU: Who were some of your mentors?

EM: I've had many mentors in my life. I learned a lot from my HP days with Dave Packard and Paul Ely, who I worked for for many years. Certainly I learned a lot from Jim Clark (founder and former Chairman of Silicon Graphics, now President of Netscape). Also, I view many of the people here at Silicon Graphics as mentors—I learn a great deal from them.

IU: Apart from the computer, what do you feel is the most important invention of the twentieth century?

EM: Apart from the computer and birth control, I think people in the future will view the twentieth century as the nuclear century. The twenty-first century, not the twentieth, will be seen as the computer-information age. I think the twentieth century will be viewed as a time of experimentation in regard to the computer, much like the nineteenth century was for the automobile. There were automobile prototypes in the nineteenth century, but the automobile is really a twentieth century invention. In that regard, you'd probably have to say the automobile is the most significant invention of the twentieth century.

IU: What's your advice to people just starting out in technology careers?

EM: You mean like "plastics?" I guess that's taken (McCracken's joking reference is to the famous career advice given Dustin Hoffman in the 1967 motion picture *The Graduate*). Seriously, there are so many opportunities for anyone who masters visual computing tools, opportunities to create content that will have an impact on the country and the world—on how we work, live, and learn. We're just getting ready to move into the Golden Age of the information era, and it's going to be about content. I'd encourage people to become a part of the digital content revolution in the next century. The other thing is to consider not being totally wired, to live a balanced life.

IU: You have an extremely busy life. How do you relax and prevent burnout?

EM: I like to stay active physically with tennis and other types of physical activities. As everyone knows, I meditate. It's become part of the lore around Silicon Valley. The meditation helps me relax. I think being active physically, having a balanced life, paying attention to your own mind are all important.

IU: Do you get a chance to read for pleasure?

EM: Sometimes. Right now I'm reading Colin Powell's book. I read a lot actually. I typically read a book every couple weeks.

IU: How would you like to be remembered?

EM: As a good father, a good son, a good husband, and a good friend. ☆

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By Shalini Chatterjee

Onyx InfiniteReality: New Flagship Machine

In an announcement that will provide an auto manufacturer, a post-production special effects creator, and a U.S. military leader with a tool in common, Silicon Graphics unveiled the Onyx InfiniteReality supercomputer January 22. The machine is capable of raw performance never seen before—the ability to process geometry, image and video data at 100 times the speed of its predecessor, the Onyx RealityEngine² graphics system.

Described as a "visualization supercomputer," Onyx InfiniteReality is the latest addition to the high-end Onyx line and is expected to service a wide range of customers due to its ability to concurrently process graphics, imagery, and video data in real-time.

How it Works

Onyx InfiniteReality has features that will address a number of application markets: geospecific texturing to create real-world geography; specialized hardware to help create virtual 3D characters; 3D imaging for electronic light table applications; and volume rendering for the diagnostic imaging of CT scan data.

Onyx InfiniteReality fills high-end 3D visualization and image mapping needs, such as government requirements for a machine to condense large images into map, terrain, or global views. Onyx InfiniteReality aids manufacturers by allowing people to do design studies on completely digitally protoyped vehicles that they can test over and over again before building any physical models. And urban planners who work in AEC (Architectural Engineering and Construction) can design and previsualize 3D buildings, allowing for trial-and-error tests that are impractical with physical constructions.

Included OpenGL

As the newest member of the Onyx family, the system features a symmetric multiprocessing architecture, offering the kind of high-end power suited to a host of vertical markets. Additionally, InfiniteReality is the first Onyx machine to support OpenGL, an industry-standard graphics library which provides important support for technical details, like texture mapping. According to Peter Lober, Senior Analyst at Datapro (Lexington, Mass.), OpenGL is growing in importance.

Wayne Collier, research analyst at D.H. Brown (Port Chester, N.Y.) explains the basic benefits. "...OpenGL is the standard API for most serious new graphics software. Before, RealityEngine was tuned to IrisGL, a slightly different API. Being tuned for OpenGL will also make it easier for the systems to take advantage of the many future extensions planned for OpenGL."

Competition—Scarce or Scary?

When it comes to competition, the real-time visualization capability of InfiniteReality is the obvious clincher. "No one else has it," Lober said.

Product Marketing Manager Drew Henry credits Silicon Graphics for keeping ahead with a healthy R&D budget. "We have a competitive advantage and other companies can't keep up with us," said Henry. "Strategy fuels our success. We sold thousands of RealityEngine² systems and we will sell thousands of InfiniteReality systems—more than RealityEngine²."

Wayne Collier, research analyst at D.H. Brown, said InfiniteReality poses a threat to rivals because it lets Silicon Graphics break in at the very high end in shops where their competitors have the majority of seats.

"This scenario clearly concerns HP, Sun, DEC, and IBM," Collier said. "It (InfiniteReality) is the first dedicated graphics hardware that has been tuned to work exclusively on these three types of media (geometry, imagery, video) in the same pipeline. Before, you could either get general-purpose processors that can work on any sort of data concurrently, or you

could get specialized processors that handle just one of these types of data."

The R10000 Factor

With the advent of the R10000 microprocessor, the company is promising sizzling results when the new microprocessor makes its way into InfiniteReality systems. Silicon Graphics expects its R10000 microprocessor to catch on quickly. "By spring it will be considered the flagship CPU, just as InfiniteReality will become our flagship graphics system," Henry predicted.

"The R10000 microprocessor exceeds the performance of both the R4400 and the R8000," continued Henry. "The R10000 CPU offers very balanced integer and floating-point processing performance, much like R4400, and exceeds the performance of the R8000 CPU. We will incorporate R10000 into Onyx (POWER Onyx will have R8000 only)."

Customers will also be able to upgrade their CPU boards (either R4400 or R8000) to R10000. All Onyx graphics subsystems (RealityEngine^2, VTX, and Extreme) can be upgraded to InfiniteReality systems—the cost and details still being worked out.

The Onyx InfiniteReality system, expected to ship this quarter, comes in different versions. The Onyx supercomputer supports 2-24 MIPS R4400 processors, 1-3 InfiniteReality or RealityEngine^2 graphics subsystems, 64MB to 16GB of memory, up to 68GB of internal disk and a maximum storage of 6.2TB. The two-processor Onyx InfiniteReality costs $208,800 and comes standard with 16MB of texture memory, 64MB of RAM, 2GB of disk, and a 21-inch monitor. A uniprocessor version is available for $125,000. The systems will sell mainly through direct sales, VARS (such as Discreet Logic), and large system integrators (such as Hughes Training).

What About RealityEngine^2?

Because InfiniteReality offers about 10 times the geometric processing performance, and attractive upgrade options are most likely being plotted, customers might wonder if the RealityEngine is worth selling anymore. Henry's answer to the question is adamant—it stays. "We will continue to sell RealityEngine^2 systems and have not planned to remove it from the pricebook," says Henry. "It is a very strong product for us and even though InfiniteReality will exceed the performance of RealityEngine^2 in all areas, RealityEngine^2 still offers faster graphics and overall system (CPU and graphics) performance than anything offered by other companies. Since InfiniteReality will be priced above RealityEngine^2, I expect that many of our customers will continue to buy RealityEngine^2, but the large majority of customers will buy InfiniteReality."

Technically, the InfiniteReality system does go much faster than RealityEngine^2. While it delivers over 10 million polygons per second, Onyx InfiniteReality provides 5 GFLOPS for image processing, the ability to download 200 megabytes per second of image data into the visualization pipeline, and a pixel rate of over 800 million textured anti-aliased pixels per second.

In fact, Collier of D.H. Brown calls the upgrade "simply stunning, if the results are as fast as reported." He commented that the remarkable range of improvements will be good for business. "It is more than fast—it's broad, and that is the most significant thing—they've been able to advance along a number of fronts at once: texturing, video, etc.," said Collier. "That's where the company's competitors will feel the pinch. Silicon Graphics definitely has competitors now who understand the tradeoffs involved in making very fast 3D graphics cards, but none of their competitors are as good as Silicon Graphics in as many different areas related to digital media."

Flight Training

Further progress from the days of RealityEngine is marked by the multiple display channels per pipeline. InfiniteReality ships with two separate display channels available in its base configuration, making the system capable of supporting two high-resolution monitors or multiple stereo headmounted display devices. With the included multichannel display generator option, the system can drive up to eight different display channels, two more than RealityEngine^2.

This feature offers a more flexible computing environment for customers who build flight or driver's training systems and require multiple displays. From a single InfiniteReality "pipeline" they will have the ability to display visual information on up to eight multiple displays. This feature will reduce the cost of the whole training system since the customer does not require a separate "pipeline" for each display.

For example, the different displays could be used in a flight training simulator for:

Display #1—Left out the window view

Display #2—Center out the window view

Display #3—Right out the window view

Display #4—Radar display simulator

Display #5—Infrared camera simulator

Display #6—Weapons system display simulator

Display #7—Heads-up display

Display #8—Instructor display

The 'Essential' Markets

One of the most interesting general aspects of the new system is the number of varied, technical, and non-technical, applications it can service. When asked which are the most important apllications, Henry mentioned post-production houses.

"Discreet Logic's FLAME and INFERNO applications are very important," said Henry. "FLAME is for video special-effect processing and INFERNO is designed for film work. And Paradigm's VEGA software is very important as well for the visual simulation market." he said.

Phil Neray, director of Product Marketing at Discreet Logic (Cambridge, MA), describes FLAME as a high-end special effects and compositing system, optimized to run on the Onyx SMP system. With InfiniteReality, Neray said FLAME can use the extra performance to do

"things never done before," such as special effects, layers and motion blur, and allowing animation to happen simultaneously.

Customers of Silicon Graphics hardware and FLAME software include Digital Domain (responsible for the current Rolling Stones video), Industrial Light+Magic (*Forrest Gump*), multimedia games, and corporations needing to simulate new products.

Collier of D.H. Brown listed medical imaging, post-production, and high-end CAD as the most essential target markets for InfiniteReality. As these markets have many image-intensive problems to solve, the work is primarily visual; InfiniteReality will be "as good or better than the previous, single-solution equipment previously sold into these markets, while adding much more versatility, and users in these areas are just starting to catch on to the value of general-purpose image processing, texture mapping, and so on," Collier said.

Collier included high-end CAD on his essential market list, because it is already relatively large and it represents a growth area for Silicon Graphics in firms that are also interested in its highly competitive IMPACT product line, Collier said. For these companies, Silicon Graphics can offer customers in large design and manufacturing shops a range of solutions that satisfy the low end needs as well as the most demanding applications.

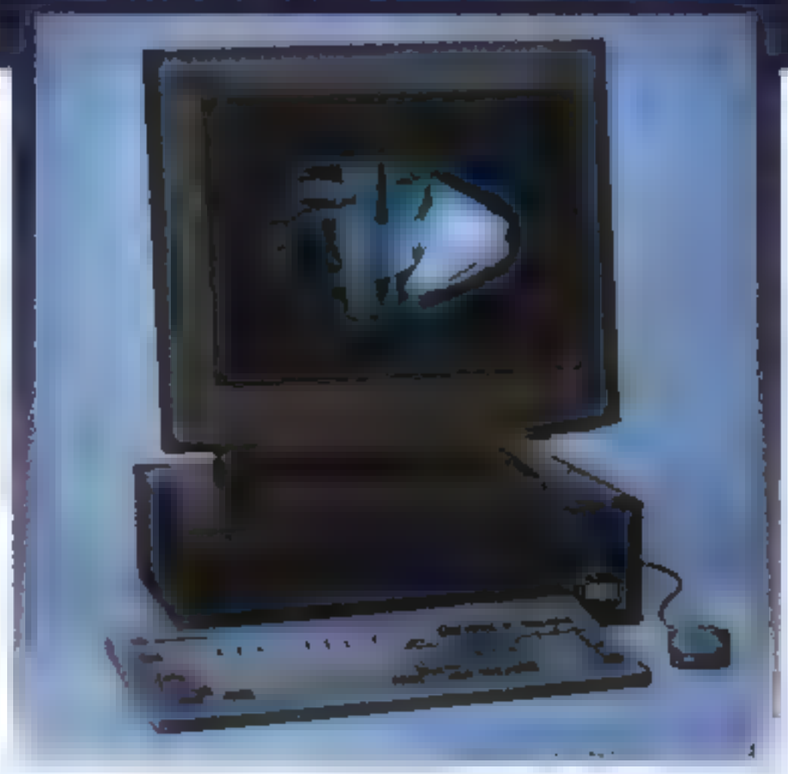
Virtual Reality

Onyx InfiniteReality offers outstanding performance for practical applications of virtual reality. Engineers can employ VR to design "virtual prototypes" without spending millions of dollars on physical mockups. Architects can test building designs without breaking ground. In short, VR can minimalize the risk and expense which naturally exists in the design process.

Because VR environments are complex, and require fast hardware, today's systems have put certain constraints on the development of advanced VR systems. InfiniteReality opens the door for better real-time interaction, providing developers with the ability to represent imagery at 60 frames per second. Because the machine is capable of concurrent processing of geometry, imagery, and video data, it can create complicated visual simulations at a consistent frame rate.

Additionally, InfiniteReality is the first workstation designed to drive stereo head-mounted displays right out of the box. It also supports all types of 3D input and output devices—gloves, 3D controllers, trackers, and projection systems. The Onyx audio option supports sound and distributed simulation tools and the built-in networking features enable multi-system virtual reality networking that could connect systems building-to-building or internationally. ☆

Indigo² Solid IMPACT



Today's design problems are more complex and require more accuracy, technical realism, and interactivity than ever before. To satisfy the growing demand in the design engineering environments, Silicon Graphics has announced Indigo² Solid IMPACT, a new addition to the Indigo² IMPACT family introduced in July 1995. Indigo² Solid IMPACT delivers outstanding price/performance for 3D solids modeling and interactive engineering analysis.

The Indigo² IMPACT line now includes three models: The new Indigo² Solid IMPACT for 3D, full-color, gouraud-shaded solid modeling; Indigo² High IMPACT for sophisticated texture-mapped 3D performance; and Indigo² Maximum IMPACT for complex desktop simulation environments when only the highest performance will do.

As the entry point into the Indigo² IMPACT family, Indigo² Solid IMPACT is priced for broad deployment in manufacturing and design, and is the perfect fit for the engineering mainstream. At an entry price of $22,000, Indigo² Solid IMPACT delivers four times the performance of the popular Indigo² XZ.

"With demands in the engineering environment increasing all the time, we're enabling designers and mechanical engineers to manipulate and interact with 3D solid models in real time," said Pamela Jackson, product market manager at Silicon Graphics. "This capability enables the designer to virtually prototype complex models, eliminating the need for physical mockup."

"This is a very important system for the sweet spot in the CAD market," said Wayne Collier, research analyst at D.H. Brown in Port Chester, NY.

As demands increase, users can easily add more features and performance by upgrading their system to Indigo² High IMPACT or Indigo² Maximum IMPACT. With hardware texture mapping, advanced image processing and even greater solids modeling performance, these graphics configurations deliver more realism, as well as interactive digital mockup and simulation.

To make the Indigo² IMPACT family even more powerful, the industry-leading MIPS R10000 microprocessor has been introduced across the entire Indigo²

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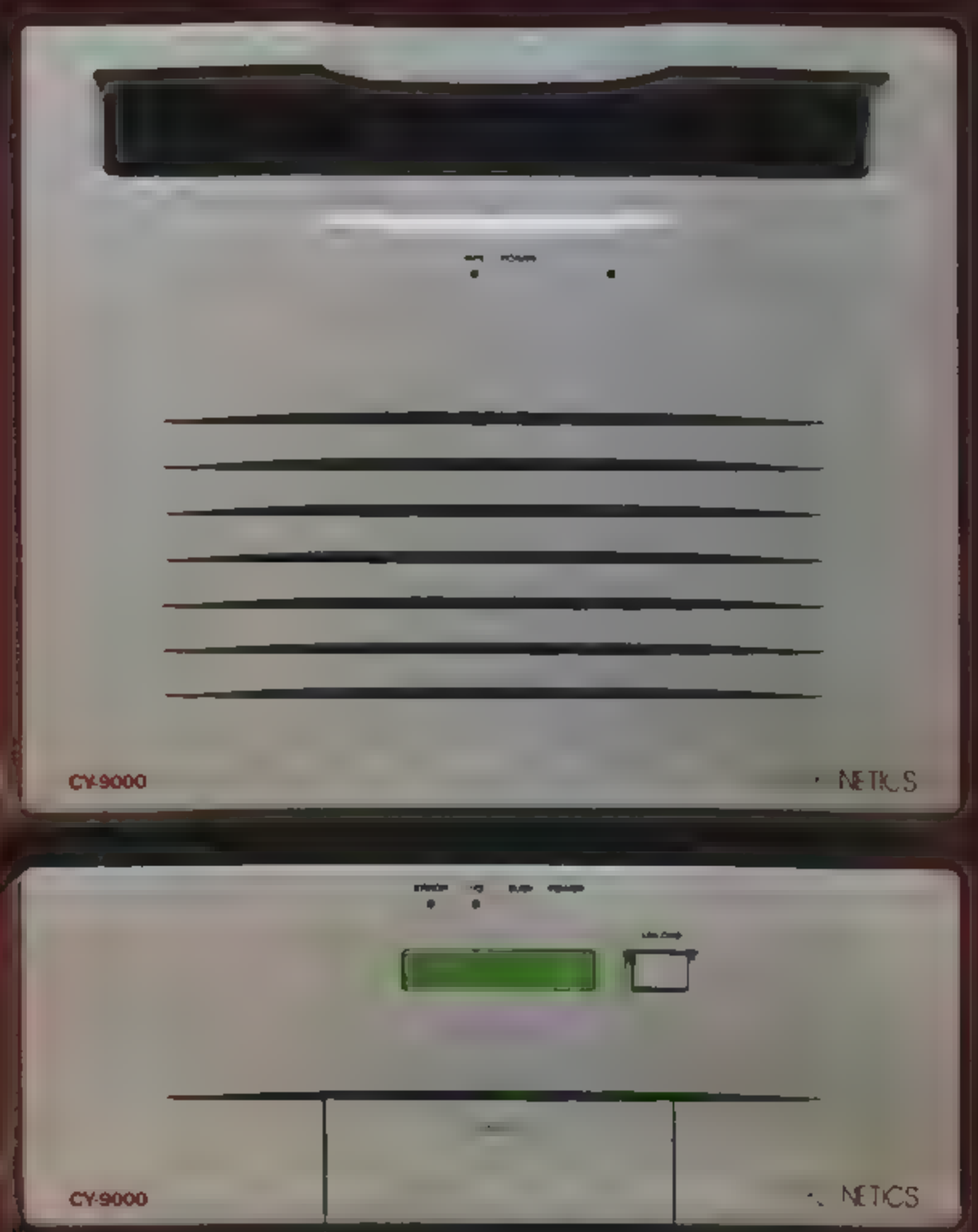

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IMPACT product line. R10000 offers a combination of leading integer performance and supercomputer-class computational capabilities, enabling new integration of applications on the desktop. With aggressive performance features such as out-of-order execution, large flexible caches, and superscalar design, the R10000 microprocessor is designed for top performance on real-world applications and provides two to three times applications performance improvement over the R4400 processor.

Indigo^2 Solid IMPACT offers three processor configurations. At the $22,000 entry-level price, customers receive a configuration of a 200MHz MIPS R4400 processor, 2MB of secondary cache, 32MB of memory, a 1GB system disk and a 20-inch monitor. It will also be available with faster chip configurations: the 250MHz MIPS R4400 processor at $27,000, and, of course, the industry-leading R10000 processor. These faster models include 64MB of memory, a 2GB system disk, 2MB of secondary cache and the same 20-inch monitor.

Because this product is such a perfect fit for the manufacturing market, the Solid IMPACT offering will include a specially configured CAD bundle—Indigo2 IMPACT Designer. This bundle puts everything you need to function in a demanding, dynamic engineering environment—high performance 250MHz CPU, Solid IMPACT grpahics with untouchable 3D solid modeling performance, expanded swap space, NFS and a variety of software tools.

Indigo2 Solid IMPACT is designed for a wide variety of uses in the manufacturing arena. With it's varied processor offerings and multi-faceted appeal, Indigo2 Solid IMPACT is well suited for meeting the dramatically increasing demands of engineers. ☆

Introducing the MIPS R5000

Exciting changes to the Indy product line focus around an upgraded entry-level workstation powered by the new MIPS R5000 CPU. The new system delivers 70 percent faster Tmesh performance over its predecessor, Indy R4400, at the same price point.

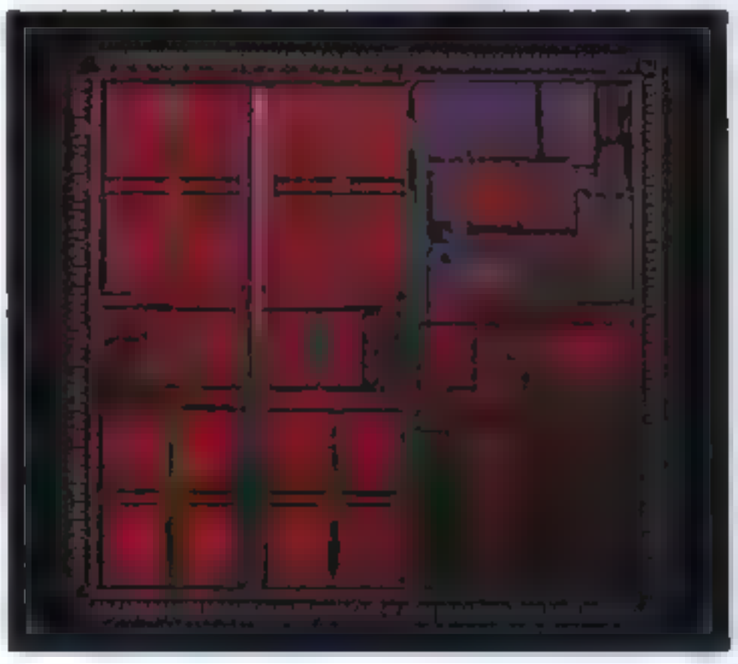
The new chip accelerates OpenGL graphics, and is designed to boost performance on visual applications according to Indy product manager Ed Schreyer. The new graphics performance is comparable to the hardware accelerated Indigo XS24 graphics which utilized twin Geometry Engines processors. Indy achieves this with R5000 Virtual Geometry Engine (VGE) 8 or 24-bit graphics.

The new CPU features a dual-issue superscalar architecture, providing a second instruction pipeline, is optimized for floating-point intensive graphic procedures, such as lighting, 3D transforms (such as rotations), and more. What this means to people in the working world is that the door to 3D capabilities is opened further, allowing a greater degree of sophistication in Silicon Graphics customers' daily lives.

One Indy market expected to greatly benefit is CAD (Computer Aided Design). Because OpenGL, a standard graphics library based on IrisGL from

Silicon Graphics, is optimized for R5000, VGE graphics performance accelerates CAD applications, which are typically power-hungry.

Web sites are expected to benefit through more serving capacity (the abil-



ity to handle more visitors at a site) and faster graphics rendering. "As content for the World Wide Web grows more visually rich, content developers will need a more capable platform," said Schreyer.

In higher education, the relatively low cost of the new 150MHz Indy workstation ($8,495) could help new technology reach more students. Digital printing and image procesing, as well as application development, are other target markets expected to see a difference in efficiency and graphical productivity.

The Indy workstation will offer the new MIPS R5000 processor this quarter in three versions: the 150MHz PC (Primary Cache), the 150MHz SC (with .5MB scache), and the 180MHz SC, (with the same .5MB cache) space. The starting price of $8,495 includes a 150MHz R5000PC, a 1GB, 32MB, VGE 8-bit system.

All systems feature binary compatibility with existing Silicon Graphics systems—meaning the same applications will run on the new machines without having to tweak or recompile them. Upgrade paths from R4400 and R4600 were being determined at press time. ☆

Shalini Chatterjee (chatrbox@sirius.com) is a freelance writer living in San Francisco.

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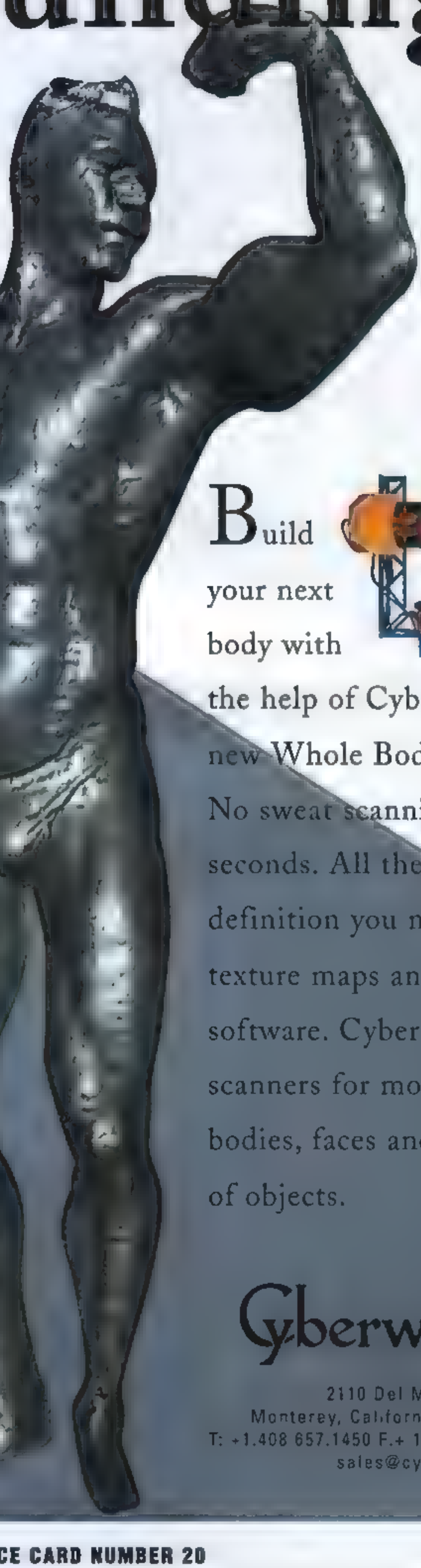
Body Building



The body builder's image began as a 17 second scan. The body builder posed on the platform of Cyberware's new WB4 Color Whole Body Scanner. The WB4 is now available for sale and demonstration. $410,000

Cyberware also provides color 3d scanners for faces and objects. The 3030/MM scanner pictured above scanned a toy tiger to quickly produce this detailed 3d model $75,200.

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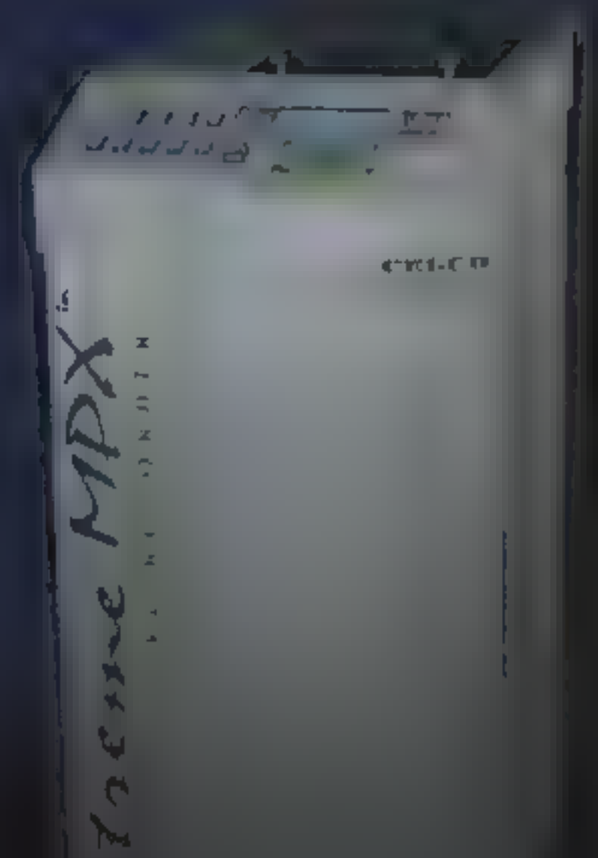

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Internet cafes are popping up all over the world—in places where people can meet over coffee or drinks while they surf the Net, exchange electronic mail, or talk with friends around the world via Internet chat lines.

By Ken Siegmann

"We get young people, retired people, and a lot of people who haven't been with computers before."

Outside the On-line Cafe [http://www.maverick.net] in Louisville, Ky. the sign says, "Great desserts, coffee offerings and a T1 connection." That's right, a T1 connection. Inside, there are a half-dozen tables with flowers, napkin holders, and Internet terminals, and another half-dozen tables without computers. People come to the On-line to sip coffee, munch gourmet desserts and browse the World Wide Web.

The Icon Byte Bar & Grill [http://www.matisse.net/files/bytebar.menu] in San Francisco advertises "American food from around the world." That may

sound like an oxymoron. The food is indeed American. The "around the world" connection is provided by an Internet terminal connected to a T1 line that sits in the center of the bar.

Internet cafes are popping up all over the world — in places where people can meet over coffee or drinks while they surf the Net, exchange electronic mail, or talk with friends around the world via Internet chat lines. Where people once hunkered down over their favorite video games, they're now parked in front of a terminal surfing the Net.

"It's the pinball machine of the nineties," says Vince Paratore, manager of the Icon.

To be sure, these combinations of bar, restaurant, and cyber salon, are opening in major cities and technology centers worldwide like New York, Boston, Los Angeles, San Francisco, Toronto, London, and Paris. But they're also showing up in such places as Wichita, Kansas, Matthews, N.C., Scranton, Pennsylvania and Vancouver, Canada Some of them are big restaurants with up to 20 Internet terminals. Some, like the On-line, have only a few terminals.

In the United Kingdom, Cyberia [http://www.indus.co.uk/cyberia/cafe.htm] has recently opened its third Internet cafe. The other two are in London and Edinburgh. Cyberia offers light snacks and Internet access, along with "Cyberhosts" to recommend interesting Net sites and help the uninitiated learn to navigate.

In the Czech Republic capitol of Prague, a group of British entrepreneurs are working to open an Internet cafe called the Terminal Bar. Using a Silicon Graphics WebFORCE CHALLENGE server, they plan to set up a 3D Web site and they are installing four Silicon Graphics Indy workstations for patrons to scan the Net and the Web.

It's a serious challenge in Prague. Permits to open the cafe have been wending their way through the Czech bureaucracy for months, but Terminal owners are confident that they will open before the end of the year. Only 32 percent of Prague residents even have telephones. Most people think surfing the Net has something to do with fishing.

"The communications infrastructure is appalling," says Chris Stander, one of Terminal's three owners. "You ask someone here if they have a telephone and they laugh at you. They really laugh when we tell them what we're doing. But more importantly, in a year's time, this will be exactly what people want."

The point, says Stander, is that Eastern Europeans are starving for information from the West and the rest of Europe. The Terminal's Internet connection is only one facet of its mission to be a key information center for Prague residents. The bar will also offer hundreds of books, magazines, and videos that are otherwise hard to get in the Czech Republic.

In the U.S. the trends among Internet cafes are more pedestrian and

"We're here to serve the culture that's out there and this is an emerging part of the culture."

certainly less political. Internet cafes are emerging as hubs to bring people together for musical, artistic, and commercial events.

The @ Cafe [http://www.fly.net] in New York City's trendy East Village district held a recent Internet event to launch a digital gallery of works by artist Uri Dotan in *i on Visual Computing* [http://www.ion.sgi.com]. Dotan uses a Silicon Graphics workstation and Alias/Wavefront software to create virtual environments and cyberscapes that wouldn't exist outside the digital world. The event featured the i on gallery on 18 terminals and a CU-SeeME video conference where Dotan chatted about trends in digital art and music with pop musician Graham Nash in Los Angeles and i on editor-in-chief Wendy Govier in Mountain View, Calif. People could access the discussion on a cafe terminal, see it on a big screen, or log in from other locations.

In October, a Virginia-based rock band called Everything [http://www.ecolon.com], launched what may have been the first "cyber tour" of Internet cafes. The band's performances for five nights around central Virginia were broadcast live over the Net to about 50 cafes in the U.S., Canada, and Europe. In some places, cyber viewers could watch the show on terminals at their tables. The @ Cafe broadcast the show on its giant video screen.

Indeed, even with a 56 Kb T1 line the video is short of television quality. It's more like watching a super-fast slide show with great music.

"The concept has been slow to catch on, but I'm a firm believer that it's going to go," says Bob Graves, owner of the On-Ramp Cafe [http://www.webserve.com/clients/onramp] in Matthews, N.C., and one of the participants in Everything's cyber tour. "It's an education process, but that's part of the pain of starting a new business."

On-Ramp has only been open since June. Although the Internet is virtually unknown to most central North Carolina residents, the terminals have kept once curious and now hooked patrons coming back.

In fact, like other cafe owners, Graves is surprised by the broad cross-section of people who are coming in to use the terminals.

"We get young people, retired people, and a lot of people who haven't been with computers before," Graves says. "The majority are people who do not have the Internet and have heard about it and want to check it out before they spend their money. We're a learning center."

Graves charges Net users $5 an hour. Some cafes charge as much as $10 an hour. At the Icon in San Francisco, the Internet terminal is free, but there's a $5 minimum at the bar.

A handful of cafes in the Los Angeles area are connected through CafeNet, a service that provides coin-operated Internet terminals and services. Some cafes report that the terminals are full most of the time with people waiting in line. The @ Cafe is planning to add more terminals to cut down on the wait. And while the terminals draw a lot of people, cafe and restaurant owners say the point is to sell food and drink.

"We live in a city with 3,000 competitors in the food industry, so it's a hook and it gives people something interesting to do," says Icon's Paratore. "We're here to serve the culture that's out there and this is an emerging part of the culture."

Ken Manford, owner of the On-line says there are lots of cafes in Louisville, but his is the only one with Internet terminals. He predicts that eventually there will be lots of Internet cafes, but for now, "Everybody is waiting to see how we do." He's confident that Internet access will be as addictive as the cafe's great desserts and coffees.

For a listing of Internet cafes, check out the Cyber Cafe Guide [http://www.easynet.co.UK/pages/cafe/ccafe.htm] on the Web or join the newsgroup at new:alt.cybercafes. ☆

Ken Seigmann is a freelance writer living in Sunnyvale, California, specializing in high-technology issues.

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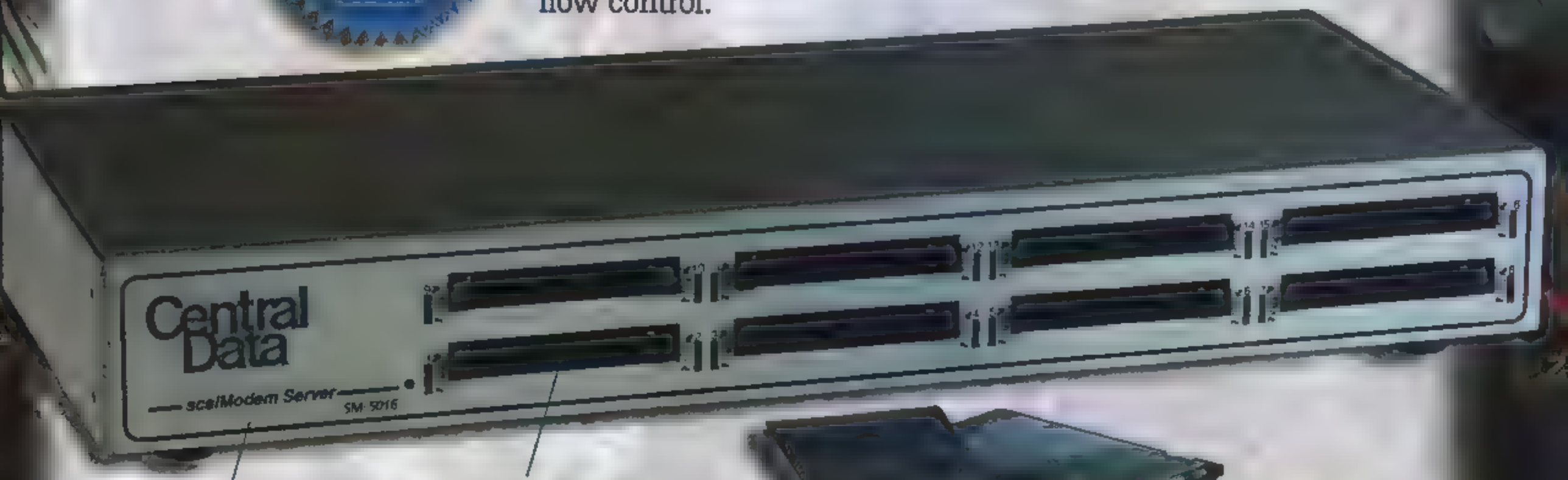

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Part Two

Seeing the Possibilities

Using Visual Computing for Competitive Advantage

By Douglas Cruickshank

"Even though we navigate daily through a perceptual world of three spatial dimensions and reason occasionally about higher dimensional arenas with mathematical ease, the world portrayed on our information displays is caught up in the two dimensionality of the endless flatlands of paper and video screen...Escaping this flatland is the essential task of envisioning information—for all the interesting worlds (physical, biological, imaginary, human) that we seek to understand are inevitably and happily multivariate in nature. Not flatlands."

Edward R. Tufte
"Escaping Flatland" Envisioning Information, 1990

In *Envisioning Information,* Edward Tufte writes that his reference to "Flatland" is based on the ideas in another book published more than a hundred years earlier in 1884. "*Flatland: A Romance of Many Dimensions,*" by Edwin Abbott Abbott (writing under the four-cornered pseudonym "A. Square") tells of a two-dimensional universe populated by a race unable to conceptualize beyond the limitations of its own world. Despite its age, Abbott's classic story is often referenced in books and articles about visual computing. The reference is an especially apt one.

In Abbott's fanciful narrative—both a social satire of Victorian England and a conceptual exploration of higher dimensions—protagonist A. Square lucidly describes his own world, as he struggles simultaneously to imagine what life would be like in a three-dimensional universe. Through Abbott's clever use of dimensional analogies, A. Square finally grasps the all-inclusive nature of seeing three dimensions and deems it god-like. As compelling as it is, visual computing falls short of divinity, but A. Square's delight at his realization is similar to what many professionals are experiencing today as they move their work from the flatland of conventional computing to the 3D, virtual world of visual computing.

The companies and individuals making the move are doing so in response to the rapidly changing landscape of business, and the intensifying challenges of competition. In many ways, these enterprises are reinventing themselves and their methods, adopting new techniques, refining and redoubling their efforts, and taking a close look at operations in order to make research, development, design, production, and marketing more efficient and effective. Companies both large and small are focusing on the ability to move fast, to make quick, well-informed decisions, and to respond promptly to fluctuations in market trends and changing customer needs.

In addition to the necessity of keeping technologically up-to-date, many businesses know that the first two companies to release a next-generation product can capture as much as 80 percent of market share. In pursuit of that market advantage, businesses are using collaborative work groups (members of which may be located around the world) and performing engineering and design efforts in parallel. They are also employing virtual prototypes and leveraging digital data for multiple uses from manufacturing to marketing to instructional video. And they are doing all of this using visual computing.

The Competitive Edge

More than three-quarters of the Fortune 100 companies depend on visual computing to help them invent their products. And in more than 30 countries, long-established companies such as John Deere, Volvo, Daimler-Benz, Sony, and McDonnell Douglas are using this new technology to meet the computing challenges that are pivotal to their competitive strength. Levi Strauss uses visual computing to stay ahead of fashion trends. Rubbermaid creates photo-realistic 3D models of new product ideas for focus group tests, substantially reducing the time and high cost of fabricating conventional prototypes. And BMW performs intensive crash analysis using visual computing, bringing both safety and economy to this essential research. Each of these companies has seen improved quality and accelerated time-to-market while reducing costs for new products.

From large companies such as Ford, Chrysler, Timex, and Boeing, to two-person design or animation studios and small engineering and architectural firms, the measurable benefits of visual computing are making its use a business imperative.

In addition, it's important to many companies that visual computing is playing a fundamental role in rapidly developing modes of interactive communication, such as the Internet's World Wide Web, interactive television, and innumerable multimedia applications.

Saving Time and Money

Whether used for designing automobiles, washing machines, wristwatches, jet aircraft, or racing yachts, visu-

al computing brings stunning increases in speed to the design process. Boeing saved "millions of dollars, and hundreds of thousands of design hours" using visual computing to design and create a virtual prototype of the 777 passenger jet—no conventional prototype was ever produced; from conception through production the only model of the new jet existed in a computer. The company also achieved unprecedented precision from design to final product. "When we went and looked at the airplane after it was built," a member of the Boeing 777 team recalled, "from the nose to the tail it was only off three-thousandths of an inch, which is just-unheard-of accuracy. And one wing was perfect. Using the new technology," the team member continued, "subsequent airplanes have gotten even better. Our original goal was to cut down change-error and rework by fifty percent. We've actually attained a seventy to ninety percent reduction."

Chrysler Corporation is the first automaker to employ a "virtual auto factory" in which all automobile design, engineering and testing is done with visual computing. The innovative system lets Chrysler engineers simulate each step of the assembly process and view it on screen before anything is actually built. Imagine being able to make a highly detailed movie of an entire manufacturing process, and change any detail at will before ever going into production, and you've got the idea. Chrysler estimates that the system reduces the time it takes to plan the manufacturing process for a new vehicle by 10 weeks.

A somewhat splashier example is Team New Zealand, winner of the 1995 America's Cup yacht race. The team has attributed a large part of its success to the use of visual computing, which made it possible to analyze between 5,000 and 10,000 design iterations over a two-month period. Team New Zealand's skipper, Russell Coutts, explained, "I can see the analysis on the computer screen, and within hours test those results on the water and feed observations to the designers."

It is not, however, solely big or high-profile business that is benefiting from visual computing. Smaller, forward-thinking firms, such as Katz Design in Montreal, Canada, have made it the foundation of their enterprise. "We're involved in product development, ranging from underwater photographic systems to cellular phones, exercise equipment and alpine skis," said Robert Katz, the company's president. "The way we design has drastically changed since we've started using visual computing. Instead of using 2D drafting, even from CAD packages, we create 3D models in the computer. Then we use those 3D models, along with other visual computing features, like sound, video, and animation, to show the products to our clients. We also use the models to communicate with tool makers, to create injection molds, and to guide manufacturers in fabricating the actual parts. That allows us to correct any problems at the prototype stage, and to substantially reduce the product's time-to-market."

Another firm, Airborne Industries Limited of Essex, England, a maker of unusual inflatables for promotional and industrial uses, reports similar success with visual computing in streamlining its previously time intensive design process. "(In the past), each 3D surface had to be converted to flat 2D panels and then drawn to scale at various viewpoints, allowing calculation of true-lengths," explained David Belton, Airborne's design engineer. "This could take weeks, depending on the complexity of the surface." Now, using visual computing in the form of AutoCAD software running on a Silicon Graphics workstation, Airborne has achieved considerable time savings, as well as other competitive advantages. "Our design engineers can construct the finished article in 3D, and then manipulate it in real-time from any viewpoint in space, or twist it around from any angle," Belton said. "The system allows us to take the required true lengths directly from the 3D wireframe representation. This is a far easier and more accurate method. We are now able to complete jobs in half the time needed previously when dealing with hand-drawn designs. This is particularly useful when someone is finding it hard to visualize the finished product. We can display the full-color 3D design on the screen, with lighting and shading as appropriate. The CAD system," he continued, "has not only speeded up our design process and increased the accuracy of the designs, but it also represents excellent value for the money."

More than three quarters of the Fortune 100 companies depend on visual computing to help them invent their products.

The above is just a handful of examples taken from the area of design and manufacturing, but, as we'll see in later articles in this series, visual computing is bringing similar advances to entertainment production, medicine, oil and gas exploration, and numerous other human endeavors. The obvious advantage of shorter design and engineering cycles is that businesses get their products—whatever they may be—to market faster, but

leading proponents of visual computing say that the more important benefit is that a project can'start later. And that directly translates into better access to technology, more time to scrutinize and improve quality, and the ability to become more familiar with customer requirements before committing to the final design of a product. It,s much easier to predict the future when the future is weeks away, rather than years.

Collaborative Work

In a sense, even when just one individual is involved, visual computing is a collaborative act. The collaboration takes place between the human brain and a machine: a powerful computer designed to capitalize on the singular ability of the visual system and the intuitive power of the mind with an unprecedented immediacy. When the human brain's lightning-like ability to grasp the meaning of images, shapes, colors, and movement combines with the computer's ability to manipulate voluminous quantities of information, a remarkable human-machine collaboration occurs. When many people and multiple computers work together, the possibilities don't merely multiply—they increase exponentially.

It's only natural that as technology has become increasingly sophisticated, its ability to make the simple act of working together even simpler is one of its most compelling features. Visual computing makes it easier than ever for many people to work together simultaneously, forming high-functioning work groups that can include participants worldwide. This has become known as "collaborative computing." Today, the need for collaboration is more critical than ever because products are much more complex, and customer demands are greater. What's more, many companies have facilities around the globe with, for example, a research and development lab in one country, financial headquarters in another, and a marketing department in yet another.

In a typical visual computing collaborative scenario, a group of individuals in different locations develop a product uses video conferencing, a virtual whiteboard, and 3D models that can be manipulated and annotated by all participants. Regardless of where in the world the group members are, they work together as if they were in the same room. This collaborative methodology—now becoming well established at companies from Ford to Varian and Boeing to Cessna—is having a tremendous impact on engineering and manufacturing due to the heightened effectiveness and efficiency it makes possible. In turn, collaborative product development is having a far-reaching effect on both business and consumers, and is profoundly changing the way that companies compete.

But true collaborative computing goes deeper than simply designing and developing a product, it starts with the initial conceptualization. In that early phase of product development, marketing information from end users (and prospective end users) is collected and incorporated into the process. The collected data is used in conceiving the product and may also be employed for marketing internally, attracting investors, and familiarizing company personnel with project requirements. The collaborators then focus on the manufacturing process, where information is supplied to those in charge of assembly or fabrication. (Individual members of the work group will typically come and go during different stages of development.) Later, the same information is leveraged once again to create manuals, instructional videos, and internal and external marketing materials. Using data in this fashion—creating it once but manipulating it for use in a variety of ways—is known as "multi-mastering."

Virtual prototyping is another capability of visual computing that is radically changing the way companies compete.

The collaborative approach substantially broadens the scope of the design and manufacturing processes to include everybody that may come in contact with the product, from inception to delivery. It also allows for engineering, analysis, design, quality control, and various other functions, which were once performed consecutively, to take place concurrently, resulting in a shortened development cycle, improved product performance, greater flexibility, and increased competitiveness.

As one manager at Silicon Graphics observed, "There's enormous value in developing data once, keeping the information electronic—digital—and leveraging that data across a variety of functional groups throughout an enterprise. One of the greatest benefits of collaboration is the synergistic effect of having several people involved in the development of an idea. It's impossible to quantify what this type of cross-functional communication can mean to a company's success. It has positive ramifications at every level."

Virtual Prototypes

Virtual prototyping is another capability of visual computing that is radically changing the way companies compete, trimming enormous amounts of time from what has traditionally been one of the most time- and labor-inten-

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sive aspects of product development. In virtual prototyping a complete model—meticulously accurate inside and out—is created in a computer instead of being laboriously constructed from wood, clay, art board, or similar material. There are no constraints as to the size or nature of the virtual prototype. Ford creates new car models this way, and Nike tries out its new shoes on a visual computing workstation long before you try them on your feet.

In addition to modeling the prototype's look and construction, visual computing can let a product development team perform wind tunnel tests, see how a dress design will move when it's produced in different types of fabric, and even project how buildings will be affected by an earthquake or how a superstructure will respond to a range of stress loads. The speed and power of visual computing allows users to interact with prototypes in a manner that is astonishingly similar to how they might deal with such an object in the real world. And in the case of architecture, aircraft development, and other large-scale projects, visual computing enables one user, or an entire work group, to "walk-through" the virtual prototype, checking every detail from wall colors to the size of screws, even the view from a window. The competitive advantage of being able to "build" something as big as a plane or a building, and then let clients, engineers and quality control personnel take an inspection "tour," is certainly one of visual computing,s most impressive attributes. Manufacturers are already saving billions of dollars thanks to virtual walk-throughs.

The few examples given above illustrate how the ways in which companies compete are changing, especially in the areas of product development and manufacturing. But this is only a sampling. The ease and control that visual computing brings to information management and analysis, communication, marketing, and the copious other aspects of everyday business are bringing change to every type of work where computers are used. As Edwin Abbott Abbott's "A. Square" discovered, seeing beyond flatland offers nearly infinite possibilities. It seems inevitable that what we now call "visual computing" will, in the not-too-distant future, simply be called "computing." The companies that prevail then will be the ones that have the foresight to understand the changing nature of business now, and the importance of going beyond the limitations of flatland.

Visual Computing's Six Principal Benefits

Like any technology, the contributions visual computing makes can differ significantly according to the type of application in which it's employed, but most users agree that visual computing's six most consequential benefits are:

- A substantial reduction in the time it takes to design products
- The ability to respond much faster to changes in the market
- The capacity to create higher-quality products
- Enhanced interpersonal communications, along with the ability to better understand and convey complex ideas and processes
- Increased and more effective innovations
- A distinct advantage over competitors, as well as a "leveling the playing field" effect

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This image is not a photograph but was created using the Lightscape Visua ization System from geometry created with AutoCAD. Image courtesy of Advanced Graphics Applications

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i on Visual Computing:

Taking full advantage of Web technology, the look of ion *keeps evolving. What you can't experience here is the opening animation on the cover of issue #3.*

Documenting a Revolution

New on-line magazine offers technology narratives rich with graphics, movies, and sound.

By Anita Schiller

The new World Wide Web-based magazine from Silicon Graphics, *i on Visual Computing,* is designed for an ever-growing audience of people interested in visual computing. *ion* documents the digital revolution that is transforming global business—from motion pictures to manufacturing.

The cyber-sister to *IRIS Universe*, *ion* was born in April of 1995 at the Web address http://www.ion.sgi.com. Silicon Graphics developed the online magazine to spotlight outstanding work being done in the visual computing arena—work that cuts across many different disciplines.

ion takes you behind-the-scenes to tell the technology story through the eyes of industry leaders. Article topics range from entertainment to industrial design, from fine art to scientific visual simulation, and more. The magazine takes full advantage of the richness of the Web by incorporating 3D graphics, animation, sound, video and text.

"Silicon Graphics is producing the ultimate resource on the Web to address interactive visual technologies and their place on emerging global supernetworks," said David Bagshaw, vice president of marketing at Silicon Graphics. *i on Visual Computing* will keep Web users' fingers on the pulse of a new era of change—a shift in the way we think, interact, and collaborate."

Silicon Graphics chose the Web medium to tell these stories because the Web offers a tremendous new opportunity to reach a broad audience, one with an inherent interest in visual computing. After all, the Web brought visualization to the Internet.

More importantly, the Web medium can do justice to the compelling story of

i on

ion's *NEWCULTURE section examines how visual computing is changing popular and traditional culture.*

the visual computing revolution. In *ion*, the audience can actually experience the wonders of visual computing—through short video clips of phenomenal movie special effects—or behind-the-scenes tours of how an application works—or even by uploading and manipulating an image.

"*ion* emphasizes the people behind the technology," said Editor-in-Chief Wendy Govier. "We've created a magazine where visual computing professionals and newcomers alike can benefit from other people's stories. Imagine the cross-pollination of ideas that can take place."

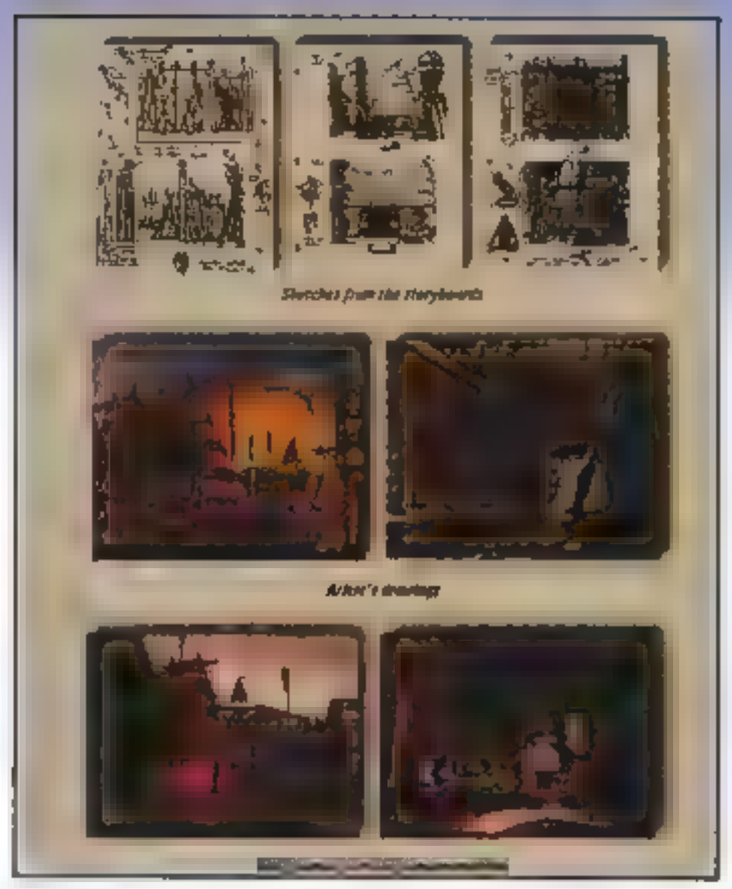
ion is presented in six dynamic sections:

STRIDES takes you inside innovative companies that are using visual computing to change the way they work.

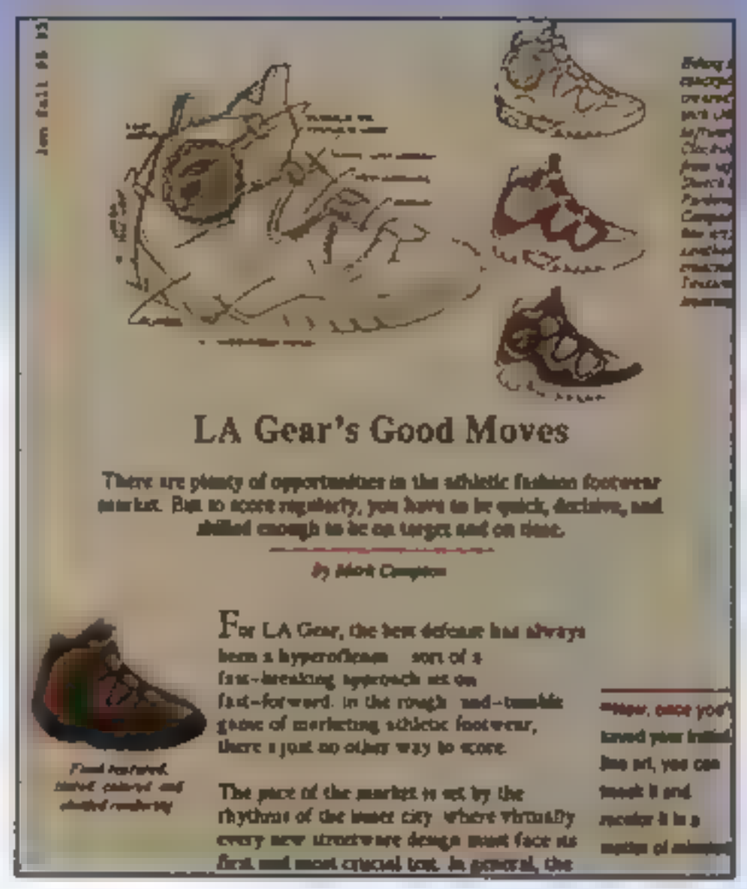
CYBERSTARS profiles visual computing luminaries, from CEOs to industrial designers - from engineers to animators.

NEWCULTURE features the evolution of cyber aesthetics—movie special-

Visual Computing



The latest issue of ion *features the magnificent computer graphics of ancient Native American cities, recreated by Santa Barbara Studios for the CBS-TV mini-series* 500 Nations.



Stories, like this one about L.A. Gear's use of CAD for hiking boot design, are presented in an easy-to-read format.

effect reviews, fine art, books, video games, and more.

WEBJUMPER focuses on Net issues, from copyrights to Internet cafes, and a cyber art gallery tour by University of Illinois Art Professor Joseph Squier.

BUZZ offers short vignettes on new products.

INTERACTIONS is an active arena for ideas, offering software step-by-steps as well as interactive exercises and games, and free images such as tiles to create Web backgrounds.

ion is the latest addition to the Silicon Graphics family of Web sites. The company has been transformed by the Web, with extensive use both inside the firewall for employee productivity and communications, and externally.

The Silicon Graphics corporate Web site, Silicon Surf (http://www.sgi.com), was introduced in early 1994, when the Web was in its infancy and few companies had ventured onto the Internet. On average, 15,000 to 20,000 visitors from around the world explore the site everyday, searching for the latest product information, including product specs, training schedules, technical white papers, answers to frequently asked questions (FAQ), and free downloadable demonstration software.

Silicon Graphics subsidiaries and partners can also be found on the Web. Check out Alias/Wavefront (http://www.alias.com), MIPS Technologies, Inc. (http://www.mips.com), Silicon Studio (http://www.studio.sgi.com), and Interactive Digital Solutions (http://www.ids.sgi.com).

And, of course, don't forget the newest family member, *i on Visual Computing*. Join Silicon Graphics in the visual computing revolution at http://www.ion.sgi.com. Keep an eye on *ion* and see what's possible on the Web. ☆

Anita Schiller is Director of Electronic Marketing at Silicon Graphics, where she is responsible for the company's strategy on the Internet.

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CIRCLE READER SERVICE CARD NUMBER 31

The Animation's Great, But It Doesn't End There

By Kenneth Orville

Ever taste a mint julep? I did once, years ago in New Orleans. There I was, under the shade of magnolias one steamy afternoon, and the words slipped out of my mouth as our waiter wrote them down. "Mint julep." I envisioned something cool and innocent—a creamy, mint-green concoction sipped on the verandah.

What a surprise, then, to discover the true nature of the mint julep. Like a glass of kerosene on the rocks, this is one hard-core highball, and none too tasty, either. "Julep" must be Cajun for rocket fuel; the "mint" comes from a measly green leaf that floats on top. Apparently, the allure of all that mint juleping down South has more to do with how you feel after you put one away than how the drink actually tastes.

So here's my point. I ordered that drink expecting one thing, and I got another. Same thing happened when I took my 10-year-old daughter to see *Toy Story*, the first full-length computer-animated movie. I expected the animation itself to be the star of the much-touted Walt Disney/Pixar production. And while the animation is phenomenal, it's not the reason to go see *Toy Story*. Director John Lasseter's new flick is superb. But instead of relying on the standout animation to be its sole claim to fame, Lasseter uses it as a powerful atmospheric tool—just a great way to tell a great story.

Pixar presents a world that is by turns fantastically plastic and startlingly realistic.

Toy Story is the tale of a pre-adolescent boy named Andy and a roomful of his favorite toys. His best-loved plaything is Woody, a string bean cowboy sheriff doll whose drawstring has him saying things like, "Reach for the sky!" and "You're my favorite deputy." The boy plays with his other toys, of course: Mr. Potato Head, Tyrannosaurus Rex, a bucket of green plastic Army soldiers, Little Bo Peep, and a motorized, remote-control dune buggy, to name a few. To Andy and his family, these toys do nothing out of the ordinary: Woody and company move only when moved by a human; Woody doesn't speak unless the string that stretches from his back is pulled.

But when humans aren't around, the toys come alive, and Woody's the leader. Holding "staff meetings" in Andy's room and addressing the group with a micro-

phone attached to a Playskool boom box, Woody (charmingly voiced by Tom Hanks) keeps everybody in line. This is a full-time job in itself, thanks to marvelous and quirky characterizations by Don Rickles as the grouchy and suspicious Mr. Potato Head, Wallace Shawn as a timid Rex, Annie Potts as an amorous Bo Peep, and Jim Varney as Slinky, a loyal weiner dog with a spring for a middle.

The stable toy culture inhabiting Andy's room is rocked one day when Andy receives a fancy Buzz Lightyear doll, voiced by a surprisingly able Tim Allen of TV's *Home Improvement*. Convinced he's the real thing and not just a toy (he's wrong, by the way), the self-important Buzz regularly calls his imaginary superiors at Star Command, then angrily huffs, "Why don't they answer?" Long story short, Buzz replaces Woody as Andy's number-one toy, and the film takes on a by-the-book buddy film plot as Buzz and Woody set out beyond the safety of Andy's house for a series of really very exciting adventures.

All of this takes place against the backdrop of Pixar's spectacular 3D animation. With 3D modeling performed on Silicon Graphics systems using Alias/Wavefront software, along with their own proprietary software, Pixar presents a world that is by turns fantastically plastic and startlingly realistic. Overall, the animation is good, with smooth, fluid motion and on-the-money texture perspectives. Lasseter, who directed the Oscar-winning 1989 short *Tin Toy*, shows off in a lot of areas with *Toy Story*, and we are the better because of it. The viewer's perspectives (or camera angles, for lack of a better term) are more dynamic than in typical animated features; the picture zooms, turns, and pans in ways that more closely resemble filmed motion pictures.

One of the most remarkable aspects of the production is its excellent lighting. Special accolades should go to the lighting team, whose bull's-eye efforts bring near photo-realism to many scenes. Whether indoors or out, the lighting in *Toy Story* is far more realistic than anything conventional cel animation can approximate. This is particularly evident in the outdoor street scenes, which are so realistic they at first appear to be filmed. The lighting has a lot to do with it.

The realism of the 3D computer animation adds to the aspect of thrill. In one exhilarating scene, Woody and Buzz try to catch up with the family station wagon by riding on a motorized dune buggy. If the scene were traditionally animated, with at least an arm's length from realism, it would be fast and funny, but more cartoonish than believable. In *Toy Story*, however, the picture is so real that the audience shouts and cheers.

Kudos to Pixar for the amazing work it's done—both in animation and in film-making—and to Disney for taking a risk and breaking the mold with Toy Story.

The beauty of *Toy Story* as a film is that it would be entertaining even if produced in cel animation. The screenplay features a rat-a-tat pace of sophisticated one-liners appropriately rationed between tots and adults alike. (As Andy opens his new birthday gifts, Mr. Potato Head fervently repeats his annual wish: "Mrs. Potato Head, Mrs. Potato Head…")

While *Toy Story* warrants a place among Disney's animated feature classics, in some ways it's better than the others. First, there's that sense of realism that only computer animation can bring. But the plot itself is fresher. Gone is the drawn-out romance between the two main characters, a staple of Disney's cartoon epics. (Probably a very popular aspect of Disney flicks among kids and many parents, but a bit predictable after almost 40 features.) Also gone are the musical numbers which, admittedly, I did not miss this time out.

But for all its differences, *Toy Story*, like other Disney pictures, has moments of poignancy. One in particular is right at the start of the movie, when Andy is alone in his room, playing with Woody and Mr. Potato Head. The toys are not alive—at least not to us—so Andy fills in the voices, moves his toys around, and creates the story as he goes along. What's striking is Lasseter's attention to detail, such as the genuine dialogue, and the subtle tricks a kid plays to turn his room into a faraway place. Watching that marvelous, well-crafted scene, *Toy Story* sent me somewhere I haven't been in a long time.

Kudos to Pixar for the amazing work it's done—both in animation and in film-making—and to Disney for taking a risk and breaking the mold with *Toy Story*. At press time, *Toy Story* looked to be a solid home run for the studio, raking in nearly $40 million in its first weekend.

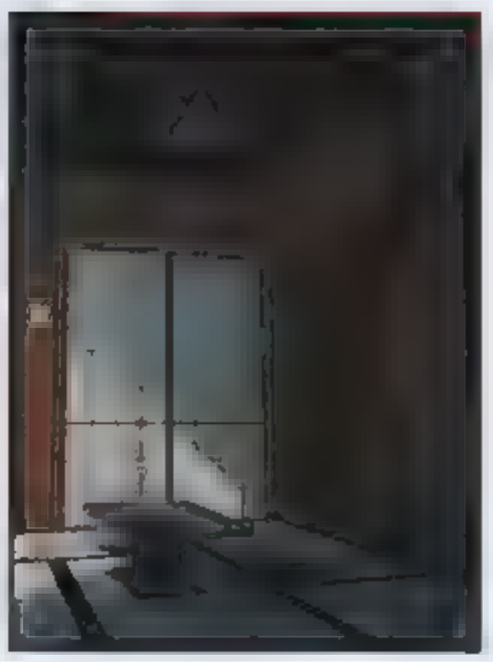
All this is good news to people who believe in computer animation. Had Pixar's animation been less sparkling, had Lasseter's script been juvenile or lame, had Tim Allen spent 87 minutes doing his *Home Improvement* Tool Time Snort, *Toy Story* may have been remembered solely as an elaborate exercise in 3D animation—an exercise not worth the effort.

As it is, though, *Toy Story* is really very memorable. Much like that mint julep I had in New Orleans. Of course, I have no trouble recalling what I did after watching *Toy Story*, whereas the details of my activities after swigging that mint julep are still a bit hazy. ☆

Kenneth Orville belongs to the ages and lives in Ontario, Canada, among other places.

these companies don't play games with VR...

MATSUSHITA



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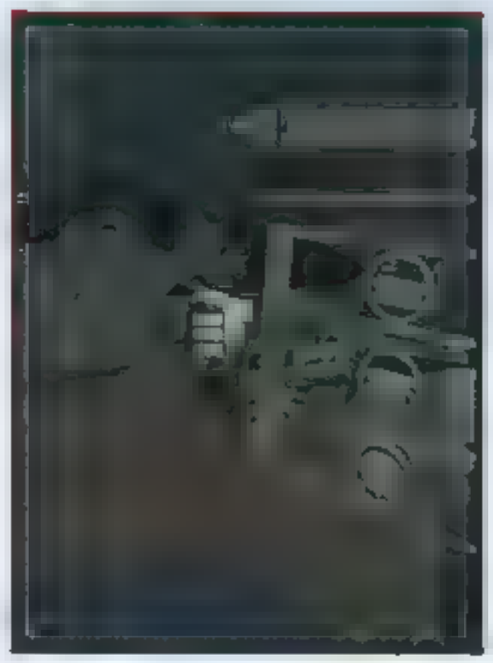

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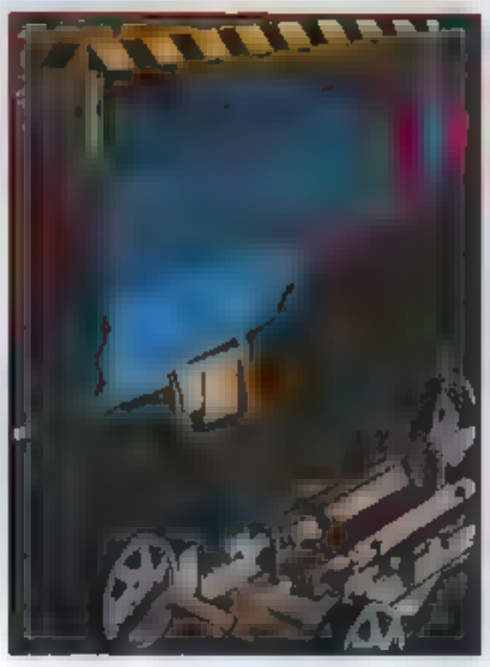

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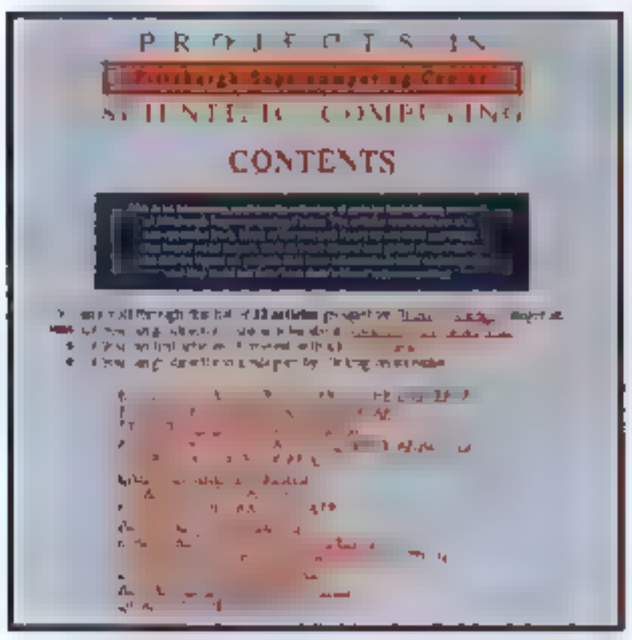
WEB GALAXY

A User's Guide to the WWW Galaxy

by Wendy Maurer

Computer visualization is the cornerstone of modern problem solving. Around the globe, scientists and engineers are using visual analysis to understand and extract knowledge from extremely large, complex data sets. The following Web sites demonstrate how scientific visualization is being used to solve the most challenging, socially significant problems.



[http://pscinfo.psc.edu/MetaCenter/MetaScience/Articles/Contents.html]

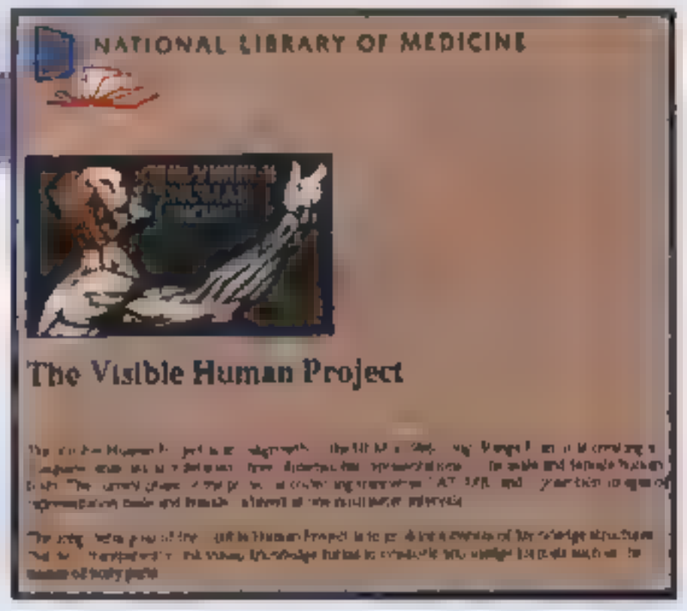
Solving the World's Toughest Problems

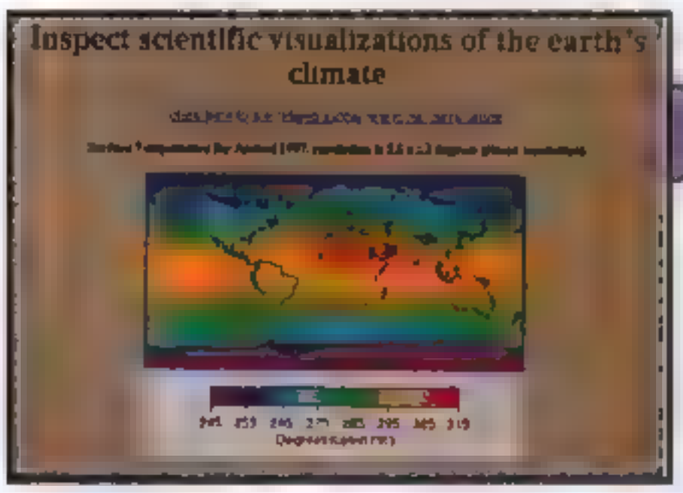
Evolution. Heart disease. Weather forecasting. These broad social problems are being studied by the scientists at the Pittsburgh Supercomputing Center. Its Web site shows how three-dimensional, color-coded models provide insight into DNA molecules. A stunning animation reveals a storm developing over Oklahoma. Accurate images of the brain demonstrate how signals travel to the retina. Clearly, the research here could not happen without powerful, scientific visualization.

[http://www.ge.com/crd/ivl/three_dim_medical.html]

Voyage through the Human Body

Fly through the skull, brain, heart, and lungs at the General Electric Corporate Research and Development Web site. Here, you can take an incredible journey through the human body with a collection of impressive images and movie clips. Study anatomically detailed, three-dimensional representations of male and female bodies. Interact with a knee. Dissect a human. It's not for the super squeamish.

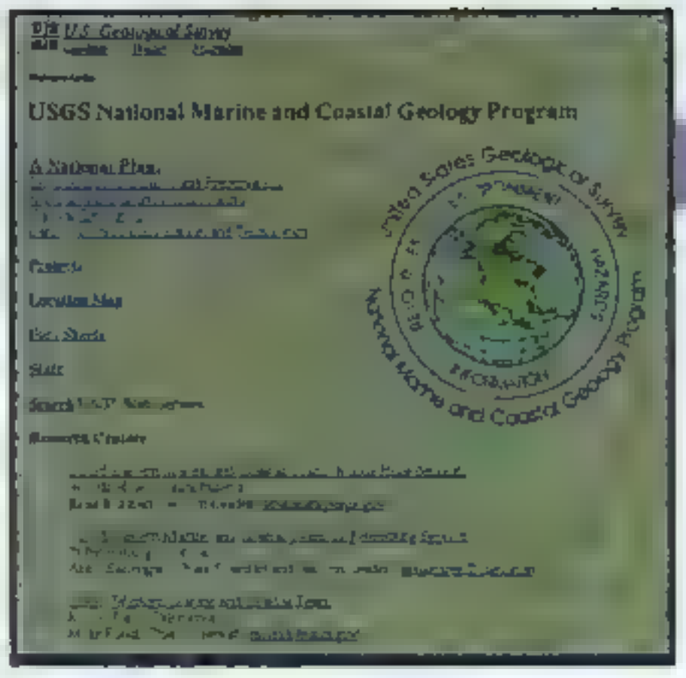




[http://www.covis.nwu.edu/gev.cgi]

Examine Global Warming

If air and gases are more your interest, examine scientific visualizations of the earth's climate at the CoVis Web site. You choose the time of year and then measure sunlight, reflective sunlight, absorbed sunlight, or energy trapped in the atmosphere during that season. The greenhouse effect is seen in a variant color band measuring energy around the earth.



[http://bramble.er.usgs.gov/]

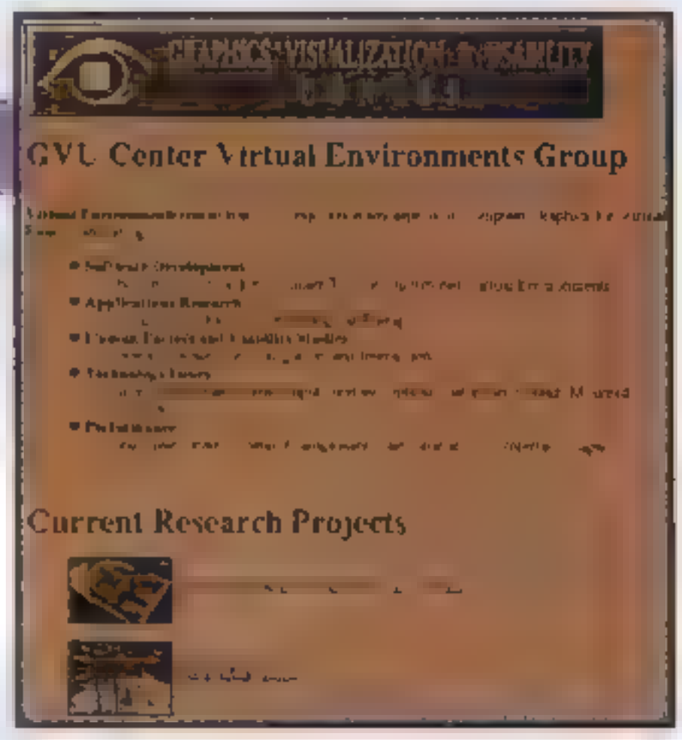
Jump into the Ocean

Scientists are addressing underwater challenges at the Marine and Coastal Geology Program Web site. Explore how coastal ocean modeling simulations of the Boston Harbor are helping scientists assess how sewage dumping impacts endangered species of whales. A beautiful image map of underwater earthquake faults beneath San Francisco Bay shows how scientists can address earthquake hazards. Images of glaciers, underwater escarpments, and ocean seismology studies are also on display. If you have specific earth science questions, a geologist is on hand to respond.

[http://www.cc.gatech.edu/gvu/virtual/VirtualEnvironments.html]

The Real Virtual Science

Do you have a fear of heights? Flying? Tight spaces? Check out the Usability and Visualization Center Web site at Georgia Tech and learn how phobia patients are immersing in virtual environments to overcome their fears. See images and animations of the virtual environments—tall buildings, planes, and elevators. But don't expect to cure your phobia through the Web. No matter what people may claim, there are no actual virtual reality sites on the Web yet. A true VR environment requires a headset, data gloves, a body suit, and a powerful visualization computer to make the action happen in real time.



A Suggestion from You

Do you know of a Web site that presents socially significant material? If you think it's worth mentioning in Webography, please let us know. Send an e-mail to wendy@sirius.com.

Wendy Maurer lives in a small fishing cottage in the hills of Sausalito and writes primarily about the Internet and other sophisticated technologies.

GRAPHICS TRIVIA QUIZ

TOM DAVIS'

Here are a few questions related to computer graphics. You'll either know the answer to the first one or you won't, but the others can be solved with a little thought.

Q:1 The viewing region for the perspective transformation looks like an Egyptian pyramid with the top lopped off. What's the name of such a solid?

Q:2 When a triangle gets its corner clipped because it's outside the window, a 4-sided polygon is drawn. Is it possible to get a 5-sided polygon by clipping a triangle? 6-sided? What's the maximum number of sides a clipped triangle can have?

Q:3 Can a perfect square be clipped so it forms a perfect equilateral triangle? Can the image of a square appear as an equilateral triangle on the screen after clipping?

Q:4 Imagine a very simple graphics program that draws a single simple white line passing through the center of a black window, and rotates slowly, sort of like a hand on a clock. Why does the line get brighter and dimmer as it rotates?

Q:5 Why is the term "normal vector" slightly misleading?

Q:6 On systems without z-buffers, the "painter's algorithm" is sometimes used to eliminate hidden surfaces. This algorithm sorts all the polygons in the drawing depending on their distance to the eye. Then they are drawn in order, beginning with those furthest from the eye and working toward the eye. Polygons closer to the eye may be drawn on top of those further away, but the effect is just as if an artist painted over the parts of the more distant polygons that are obscured. Aside from the performance problem (you need to sort all the polygons before each rendering), will this scheme always work?

Q:7 Sometimes when a polygon is rotated in space just right, it is viewed edge-on, and becomes a line segment. On a very early Silicon Graphics system, rather than write special-purpose polygon rendering microcode to draw such polygons, we just used the line drawing routines. Why was this a bad idea?

GRAPHICS TRIVIA ANSWERS

A:1 *It's called a "frustum" of a pyramid. For some reason, most people think it's called a "frustrum." I don't know why.*

A:2 *Polygons (including triangles) are clipped against the six faces of a cube, and clipping against each face can generate at most one more side, so nine sides is the most possible. There is an orientation of a 3D triangle that passes through the interior of the cube and hits all six faces and has all three edges partially inside the clipping cube, so a nine-sided clipped triangle is possible.*

A:3 *Sure. Choose any long diagonal of the clipping cube and draw a large square perpendicular to that diagonal near a corner. It will be clipped to an equilateral triangle in 3-space, but due to projection, will not appear equilateral on your computer screen. To make an equilateral triangle on the screen, use an orthogonal view, and imagine the square with a corner straight up, then rotated about the diagonal through that corner until it appears as a 60 degree angle. Use the lower clipping plane to whack off the bottom.*

A:4 *On Silicon Graphics hardware, the default lines are drawn so that lines with a slope of less than 45 degrees intersect each vertical row of pixels only once, and lines greater than 45 degrees intersect horizontal rows of pixels only once. For horizontal or vertical lines, one pixel is turned on per pixel of distance. For 45 degree lines (the extreme case) a pixel is turned on only for every 1.414 pixel units, and hence will appear dimmer. See figure 1.*

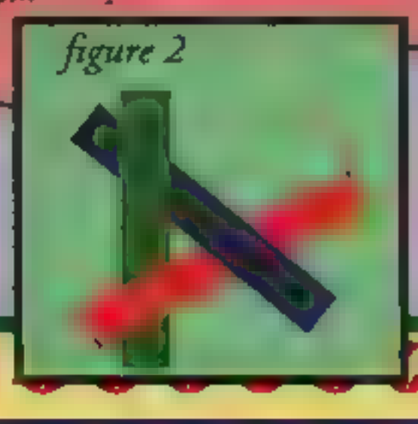
figure 1

A:5 *There are actually two reasons. First, the term has come to mean a vector that is perpendicular to the surface, usually (but not always) having length 1. "Normal" is short for the mathematical term "ortho-normal," where "ortho" means perpendicular, and "normal" means "normalized," or having length 1. Hence, it would be much better to call them "ortho vectors."*

Second, normal vectors are very different, mathematically, from the vectors that describe points on a surface. If v is a point on the surface, n is the "normal vector" there, and M is a transformation matrix taking v to v' and n to n', then mathematically, v is a column vector (in OpenGL), and n is a row vector. v' = Mv and n' = nM^(-1). In mathematical terms, one is covariant, and the other is contravariant.

A:6 *No. It's possible with as few as three convex polygons to generate a picture that is impossible to render correctly with the painter's algorithm. See figure 2.*

figure 2



A:7 *Usually it worked fine, but polygons have different attributes from lines. In particular, lines have a stipple pattern, and polygons have a pattern. When the degenerate polygon was drawn as part of a surface where it connected to non-degenerate polygons, the polygon pattern would suddenly change to a line stipple, with quite disturbing visual effects.*

Even for non-patterned polygons this can be a problem if there is any transparency. Polygons are drawn "point-sampled" so that pixels belonging to adjacent polygons are not drawn twice. If the edges are drawn twice in transparent mode, the solid will appear to have a ghostly "webbing" at the polygon edges.

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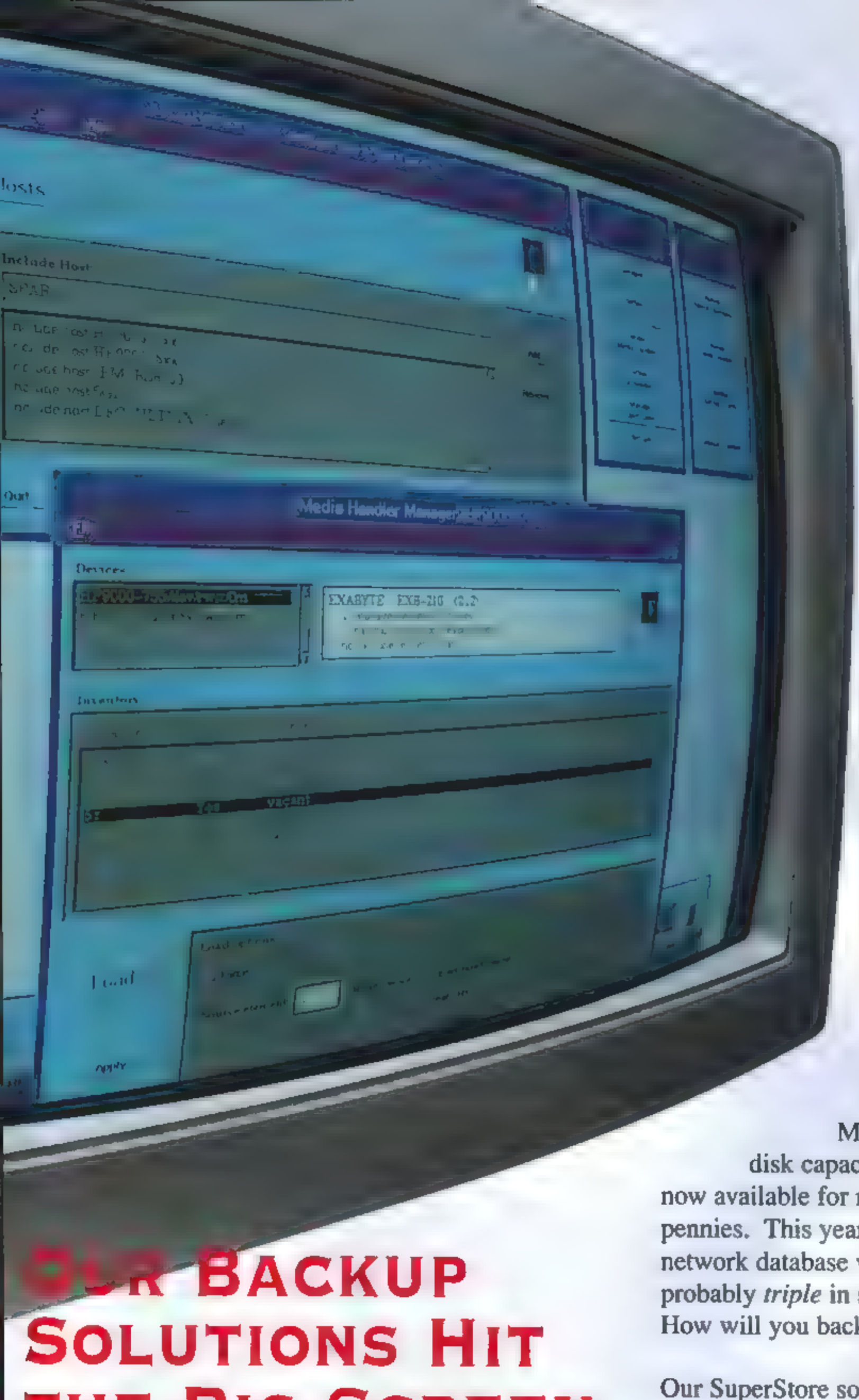

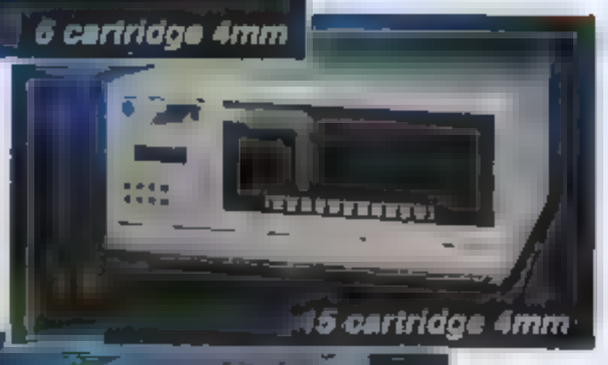

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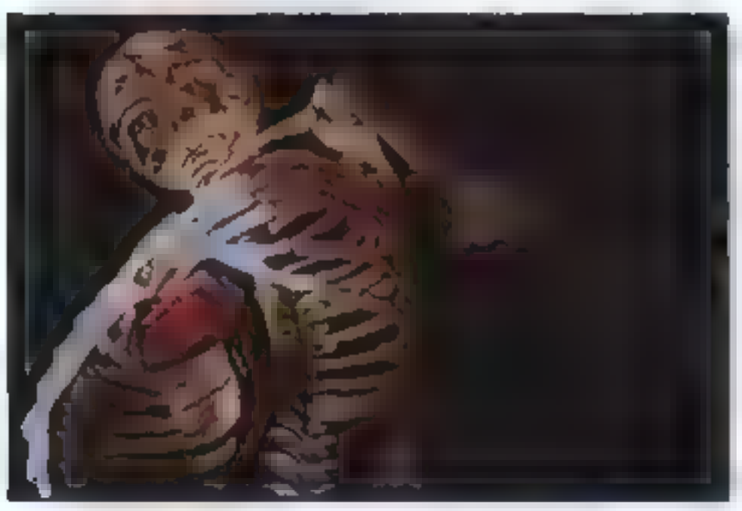
RANDOM NOTES

EAI REVIVES JESSE JAMES

We begin this edition of Random Notes from the Field with a blast from the past —the somewhat distant past. You may recall the hubbub last summer about the real identity of the body buried in gun fighter Jesse James' grave. James was assassinated by a member of his own gang in April 1882 and buried on his family farm in Missouri. His remains were moved in 1902 and reburied next to his wife. For more than a century, there has been con-

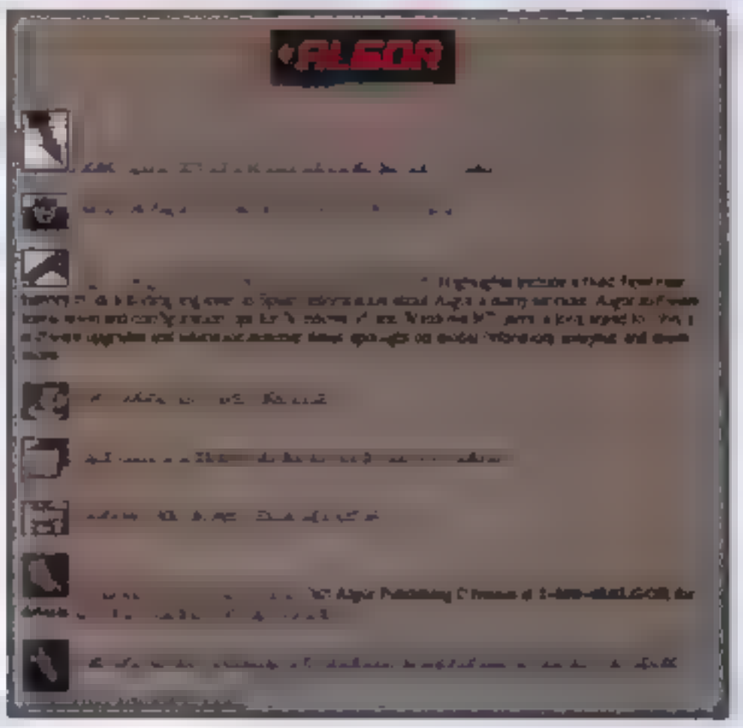
troversy about whether it was really Jesse James who was killed. Well, the folks at Engineering Animation, Inc., in Ames, Iowa, helped with the investigation to resolve that question. The remains of James' body were exhumed under court order last July. Investigators used EAI's



animation technology to gain some historical perspective on his life and death. They simulated a model of James' home and used EAI imaging techniques to construct a model of James' body and trace the path of the bullets that killed him. The researchers determined that it probably was James in the grave and he was reburied in October.

ALGOR HITS THE WEB

Back in the non-academic world...Algor, Inc.—no, not the vice president of the United States, the producer of mechanical and design analysis software—has launched a new World Wide Web site. The site



features multimedia presentations of the company and its products. It's as close as you can get to a live product demonstration without actually having a company representative do it in your office. You can check it out at http://www.algor.com.

VIRTUAL TECHNOLOGIES' GESTUREPLUS

While we're talking about cyber stuff, let's move on to virtual reality. Virtual Technologies in Palo Alto, Calif., has begun shipping its GesturePlus gesture recognition system at an introductory price of $3,500. Connected to a host computer through a simple RS232 serial port, GesturePlus recognizes user-definable hand gestures with the company's CyberGlove instrumented glove. The company has enhanced the CyberGlove to make it more comfortable and easier to fit.

OXFORD'S PROTEIN DATABASE SYSTEM

And now on to the small stuff. Really small. In fact, molecular. Oxford Molecular Group PLC, London, a producer of computer-aided molecular design software and bioinformatics tools, has launched version 3.0 of its Iditis unique protein structure database system. The new version stores more than 500 fields of data for each published protein structure derived from the latest Protein Data Bank (PDB), using only 60 percent of the hard disk space in an equivalent PDB release. The new version allows molecular and structural biologists to perform in-depth structural analysis at nearly twice the speed of the previous release. Oxford also released a companion product called Iditis Architect 1.0, an integrated suite of data derivation tools that allows users to include their proprietary protein structures in the Iditis database tables. That simplifies the task of validating and characterizing proprietary 3D protein structures using structural validation tools that have been adopted by the PDB for checking all deposited structures. For information call (800) 544-6634.

QUICK RESTORE V2

On more mundane matters, Workstation Solutions in Amherst, N.H., a supplier of network administration technology, has unveiled Quick Restore V2, the latest version of its backup and restore software for Silicon Graphics workstations. The new version will enable managers of heterogeneous networks to streamline administration with a common graphical user interface. For information call (603) 880-0080.

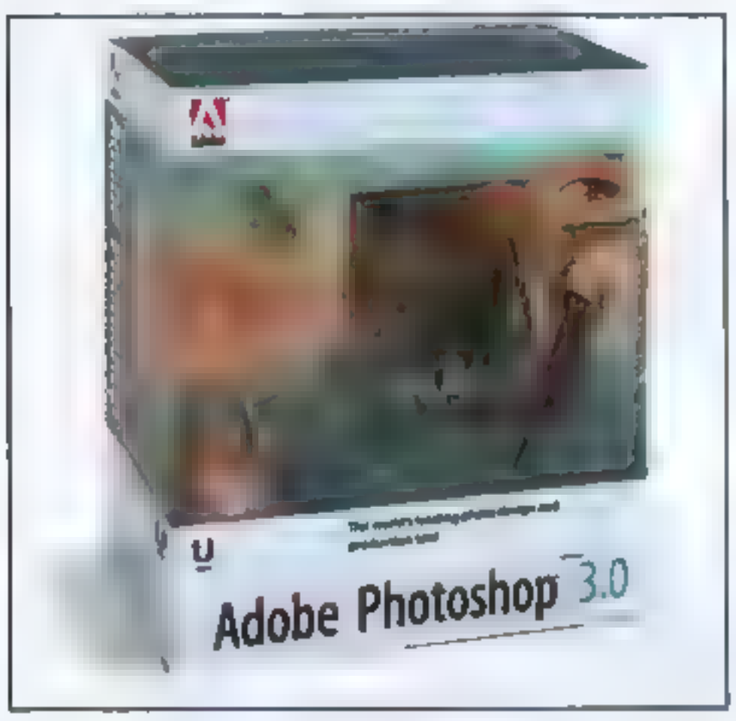
DISKINFO FROM PDC

While we're talking about system maintenance, its worth noting that PDC in King of Prussia, Penn., has introduced DiskInfo, a tool that automatically anal-yses disk usage across heterogeneous UNIX networks for the Silicon Graphics platform. As networks expand, administrators can use DiskInfo to get continuous information to deter-

mine which files can be removed, migrated, or archived to near-line or off-line storage. The program costs $2,495. For information call (800) 654-4732.

PHOTOSHOP 3.0

Back to end-user applications, Adobe Systems, Inc. in Mountain View, Calif., has rolled out version 3.0 of its Adobe Photoshop for Silicon Graphics and Sun Sparc workstations. Photoshop 3.0, the leading design and production program, was designed to take advantage of recent enhancements



to the Silicon Graphics IRIX operating system. New features include multiple layers that give users more creative control by working with individual images in separate layers. This enables creative professionals to experiment before they commit to an image or design idea. Other new features include an improved interface, customized menu arrangements, color masks to quickly access or edit selections on an image, and new filters for such things as lighting effects. Licenses range from $995 for a single user to $13,495 for a 10-user floating license. Registered Photoshop owners can upgrade for a single-user price of $495. For information call (800) 477-8830.

DYNAMO FOR PRODUCT DESIGN

Tecnomatix Technologies, Inc., in Novi, Mich., has taken some of the mystery out of design for manufacturing. The company has launched a new program called Dynamo, which lets manufacturers visualize how parts will fit together in consumer or industrial products on automated assembly lines. Using Dynamo, designers and manufacturers can spot difficulties with assembly early in the design process. By using computer visualization to correct manufacturing problems before products get into production, companies can cut product development costs, reduce the chances of production delays and make products easier to service. Dynamo has already won an important endorsement. Renault, one of Europe's largest automakers, will use the program in its car designs. The program lets manufacturers skip expensive physical modeling and instead create digital mock ups to test manufacturability.

A typical configuration of four to six Dynamo seats on a network costs between $19,000 and $22,000. For information call (810) 471-6140.

TOWEREIFFEL'S OBJECT-ORIENTED TOOL

TowerEiffel has arrived. No, we're not having a dyslexic episode involving France's best-known landmark. TowerEiffel is an object-oriented software engineering and development system for Silicon Graphics, developed by Tower Technology in Austin, Texas. Eiffel has been a popular software engineering environment on other UNIX platforms, as well as OS/2 and Windows for a couple of years. As an object-oriented development tool, it combines an object-oriented programming language with powerful engineering support and an intuitive structure and syntax. TowerEiffel features interoperability between C and C++. This way, developers can use existing C++ libraries to add software engineering support and/or memory management to C++ programs. Other features include easy-to-learn syntax, fast executable code, global system optimization, user controllable garbage collector, exception handling, parametrized types, automatic system builds, and document generation. Individual licenses cost $249. Commercial developer licenses are available for $1,555. Both packages include the Eiffel 3 compiler, development environment, and programming tools. For information call (512) 452-9455.

RAPIDTOOL PROTOTYPE MOLDS

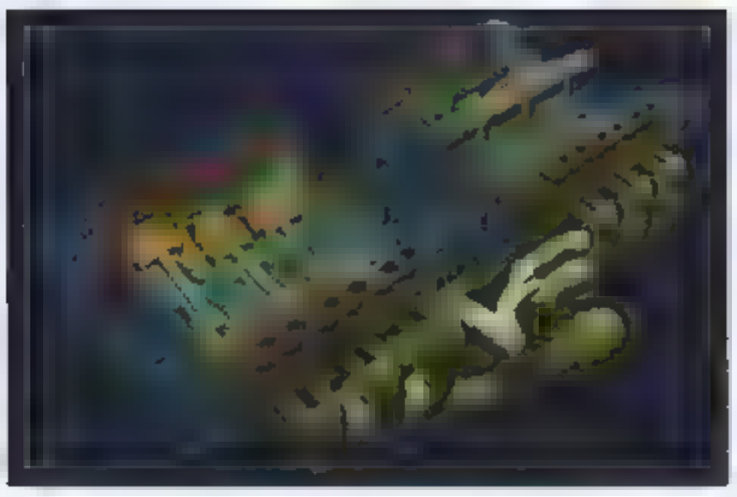
The DTM Corporation in Austin, Texas, says it's on the verge of a revolution in rapid prototyping. The company has begun beta testing its new RapidTool Process to quickly create prototype injection molds and tools. The University of Louisville and Xerox Corp. are among the beta testers. Using the RapidTool process, people can quickly produce complex mold inserts. In fact, DTM says RapidTool cuts the process to two weeks, compared with 12 to 15 weeks with conventional manufacturing methods. For information call (512) 339-2922.

NATIONAL FILM BOARD OF CANADA

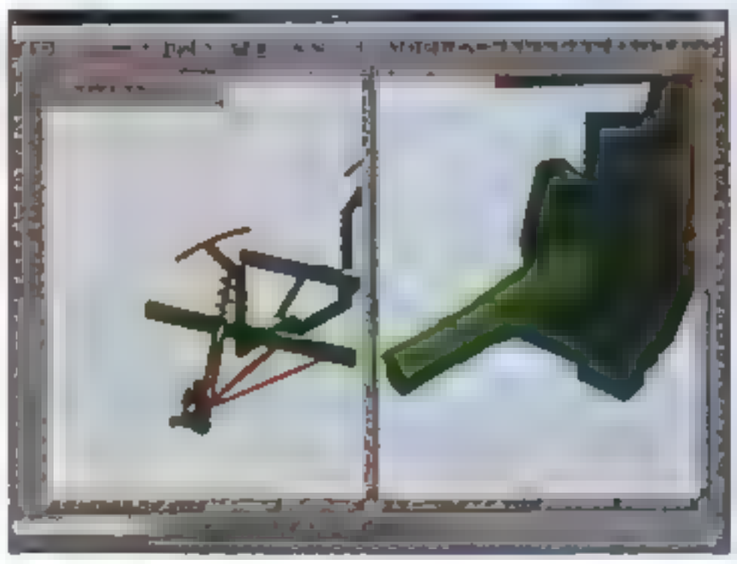
Kudos to the folks at Eastman Kodak Company. The National Film Board of Canada has purchased a Cineon Genesis 35 digital film scanner and a Silicon Graphics Onyx supercomputer-based Cineon Image Station 4004 workstation from Kodak for its Visual Effects and Graphics Services facility. With the equipment, NFB can provide advanced digital compositing services at its animation, documentary, and multimedia studios. The NFB is planning to use the equipment to switch from conventional animation shooting and optical special effects and titles to digital technology.

GREEN DESIGN COMPETITION

Bow for bit of environmental awareness, courtesy of the folks at Bentley Systems, Inc., in Exton, Penn.



Bentley, a leading supplier of CAD products, has launched its annual Student Design Competition around the theme "Green Design: A Quest for Environmental Solutions." Throughout the year, students are submitting CAD-based designs in various engineering and design fields, with an emphasis on environmental issues that they will encounter in their professional careers. Of course, all of the entries must be created using Bentley's MicroStation CAD program that runs on UNIX, Power Macintosh, Windows, and Windows NT platforms. The winners in each design category will receive a Power Macintosh and a copy of MicroStation, valued at $9,000. At the same time, Bentley has introduced a special MicroStation Academic Suite for students and instructors for $190. The package includes MicroStation V5 for 2D and 3D design, MicroStation Modeler high end solid modeling program, MicroStation Masterpiece for engineering visualization, and MicroStation PowerDraft drafting program. These are all full-function, unrestricted products that would be worth $9,000 if sold outside an academic setting. We applaud Bentley's commitment to education and the environment. For information call (610) 458-5000.



PEOPLE ON THE MOVE

The Acclaim Coin-Operated Entertainment division of Acclaim Entertainment Inc. in Mountain View, Calif., is beefing up its technical and creative staff. The company recently hired two new artists, a programmer, and an electrical engineer.

Hired are James Hunkins, senior electrical engineer in charge of hardware development, and senior artists Ed Pearson, and Jason Leong, who will create the visual effects for Acclaim's forthcoming arcade games. The company also hired Tom Desmarais as its lead programmer. All have extensive experience in computer graphics and game technology. ☆

This Just In....

"Good evening Mr. and Mrs. America and all the ships at sea. This just in...once again we invoke the immortal words of Walter Winchell, the great media pioneer, to launch a new edition of "This Just In" for *Iris Universe*. I guess one of the reasons why I'm so fascinated with Winchell is that he broke new ground in the style and manner in which information was communicated. Silicon Graphics is doing the same thing, albeit without Winchell's funny-looking fedora and the telegraph clicker."

Avid to Deliver: Silicon Graphics took the wraps off of one of its pioneering efforts recently when it announced that it is teaming up with Avid Technology in Tewksbury, Mass., to deliver technologies and products that will accelerate the movement to all-digital production for broadcast and post-production. Avid is a leading producer of products used to capture, create, and edit digital media on a variety of platforms. For broadcasters, that means Avid's cutting-edge MediaServer production system will be available on the Silicon Graphics CHALLENGE family of servers. This comes at a time when more and more prominent broadcast facilities are installing server-based news production systems. "We're experiencing the benefits of server-based news production three times a day, with each newscast we record, edit, and air using Avid's MediaServer production system," said John Hayes, television vice president for Providence Journal Broadcasting. "We believe the technologies advanced by both Avid and Silicon Graphics will continue the transition to all digital, on-disk, networked production in the broadcast industry." For the folks in post-production, the alliance means that Avid's hot image processing and imaging solutions will be able to exploit Silicon Graphics advanced digital media capabilities. Avid's Media Spectrum, a complete, disk-based on-line suite for high-end finishing, will also soon be available on Silicon Graphics Onyx graphics supercomputers. Avid plans to leverage the entire Silicon Graphics product line. "We believe this announcement will lead to solutions that will allow us to be more flexible in our future productions and will deliver outstanding results in our upcoming films," says Rick McCallum, a producer at Lucasfilm Ltd. "The combination of Silicon Graphics hardware and Avid application software will be a leap in progress that the industry has been missing."

Netscape on the World Wide WebFORCE: those interested in commerce on the Internet just got something to smile about. Silicon Graphics and Netscape Communications have announced that Netscape is making its family of Netscape Internet Applications available on the WebFORCE product line. The Netscape Internet Applications are a family of turn-key software applications for full-scale commerce on the Internet. They include the Netscape Merchant System, Netscape Publishing System, Netscape IStore and the Netscape Community System. The Netscape products are the first applications to integrate high-volume transaction processing, real-time data management, easy-to-use interfaces, and encrypted communications to create really cool on-line services and large-scale businesses on the Internet. Combine that with the hot authoring and serving capabilities of WebFORCE, and it's almost too hot to handle.

Speaking of Hot: they're going to need a fire extinguisher up there in the

finance department at the rate things are going. Silicon Graphics recently announced that it leads the industry in revenue growth, and its earnings don't look too shabby either. The company's sales grew 33 percent to $596 million in the first quarter that ended September 30. Profits jumped 28 percent to $58 million, while earnings per share grew 27 percent to 33 cents per share. Demand for Silicon Graphics desktop systems unit sales grew 38 percent from last year's first quarter as Indy continued to be a hot item and Indigo^2 IMPACT gained quick acceptance among graphics-hungry users. The instant popularity of the WebFORCE servers in the six months since its introduction has made the World Wide Web the fastest growing market for Silicon Graphics. That business grew 35 percent over the previous quarter. CHALLENGE and POWER CHALLENGE high-end server business also looked pretty healthy, growing 39 percent year-to-year. And POWER CHALLENGE changed the competitive landscape by jumping ahead of the pack with 37 percent market share in departmental supercomputing. Silicon Graphics CEO Ed McCracken was last seen on roller-skates with a rocket engine strapped to his back.

Silicon Bundle: a lot of Silicon Graphics financial success results from a series of smart moves—moves like this one. Silicon Graphics is now bundling a slew of individual productivity and group collaboration tools with its desktop systems. Every Indy and Indigo^2 workstation is now shipping with Silicon Graphics InPerson desktop videoconferencing software, its Web-based communication tools, plus Insignia Solutions' SoftWindows and Adobe Acrobat Reader. That means every Indy and Indigo^2 system comes ready for real-time video-conferencing and World Wide Web authoring and navigating, and with the capability of running all Windows applications, and the ability to view documents in a variety of formats. Talk about complete. "The key to competitive productivity is the ability to communicate and collaborate in the most powerful way possible," said Tom Furlong, vice president and general manager of Silicon Graphics digital media systems division. "Arming our customers with advanced collaboration tools delivers on our commitment to provide solutions that truly stand out in performance and quality."

Fast Fast: Silicon Graphics has set the new Informix database performance record by hitting a TCP-C benchmark result that represents a 79 percent increase over the previous record. That means Silicon Graphics achieved 6,313.78 transactions per minute (TCM/C) on the Transaction Processing Council benchmark. The TPC-C is the industry-standard benchmark to measure OLTP performance. The results essentially blow the doors off of the old record of 3,543.20 TCM/C set by Sun Microsystems. Silicon Graphics hit the new record running the Informix On-Line Dynamic Scalable Architecture (DSA) 7.1 relational database management system in a client/server configuration using a 16-processor CHALLENGE XL symmetric multiprocessing server and seven CHALLENGE S front ends. Silicon Graphics achieved this landmark running a CHALLENGE XL server configured with 20 processors fewer than the machine's maximum configuration. That's sort of like winning a fight with one hand tied behind your back. But that's not all. The record achieved a cost of $481 per TPM/C, making Silicon Graphics the price/performance leader. Sun held the previous record at $495 per TPM/C. Silicon Graphics left 'em in the dust.

Big Stuff: Europort-2, the European supercomputing consortium, has selected Silicon Graphics POWER CHALLENGE multiprocessor supercomputing system as an official parallel processing architecture. Partially funded by the

European Commission, Europort-2 is a formation of 32 consortia of leading European industries and institutions that are working to demonstrate the significant performance improvements and competitive advantages that parallel processing can bring to industry problems. The consortia expects to port 38 large third-party and in-house serial codes to SMP and array architectures in the next two years. The agreement calls for the installation of a 64-processor POWER CHALLENGE system at the Silicon Graphics European Supercomputing Technology Center at the company's manufacturing site in Cortaillod, Switzerland. The system will be used as a benchmark and proof of concept platform to demonstrate the performance of parallelized applications in computational chemistry.

HP On Board: Hewlett-Packard Co., the nation's second largest computer company, has licensed OpenGL, Silicon Graphics premiere application programming interface for 2D and 3D graphics applications. The Palo Alto, Calif., computers and instruments giant joins 34 other leading companies that have licensed OpenGL, including IBM, Microsoft, Hitachi, SunSoft, Intel, Digital Equipment, NEC, Sony, Intel, Harris Computer, and NEC, to name a few.

Kudos, Congratulations and People Stuff: a big congratulations to Silicon Graphics boss Ed McCracken, who recently received the National Medal of Technology from President Clinton. The medal is awarded annually and is considered the nation's highest honor for technological achievement. California Governor Pete Wilson nominated McCracken "for his ground-breaking work in the areas of affordable 3D visual computing and supercomputing technologies; and for his technical and leadership skills in building Silicon Graphics into a global advanced technology company." Good going, Ed....Robert A. Lutz, the president and chief operating officer of Chrysler Corp. has joined Silicon Graphics board of directors. Lutz has been a member of Chrysler's Office of the Chairman and served as president and COO since 1993....Chu W. Chang has joined Silicon Graphics as vice president of the Global Customer Support Division. He's responsible for all aspects of customer support, including revenue attainment, customer satisfaction, and consistency in support.

A Penny for Your Thoughts: MIPS Technologies, Silicon Graphics microprocessor subsidiary, has launched a nationwide contest to award to a U.S. primary or secondary school one penny for every MIPS processor shipped in 1995. Given the high volume of MIPS microprocessor shipments, that could mean tens of thousands of dollars to a U.S. school to help defray the soaring cost of education. Any primary or secondary school is eligible by filling out a form that states its most pressing financial need.

Spreading out on the Web: Silicon Graphics and Netscape Communications (these guys just can't stay away from each other) recently announced that together they are endorsing a powerful set of technologies that will enhance 3D, multimedia, and interactivity on the Web. The two are throwing their weight behind Java, Sun Microsystems' programming language; Silicon Graphics' Virtual Reality Modeling Language (VRML), and Netscape's JavaScript scripting language for Java. Silicon Graphics is also teaming up with Sun and Macromedia, a leading producer of multimedia authoring tools, to define a new set of open multimedia formats and application programming interfaces. The point is to speed up the development of cross-platform applications and multimedia content for the Internet.

By Ken Seigmann

ADVERTISER INDEX

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January Through March 1996	LOCATION*					
4D SERIES COURSES	**WEC**	**EEC**	**SEC**	**DEC**	**BEC**	**LAEC**
Introduction to IRIX 4.5 days	Jan 22 Feb 12 Mar 4&18	Jan 8 Feb 5 Mar 4	Jan 22 Mar 25	Jan 8&29 Feb 26	Jan 29 Feb 12 Mar 11&18	Jan 29 Feb 26
Open GL Programming 1 4.5 days	Jan 29 Mar 4	Jan15	Mar 18	Feb 12	Feb 26	Apr 1
Open GL Programming 2 4.5 days	Feb 5 Mar 11	N/A	N/A	Apr 1	N/A	N/A
IRIX IM Programming 4.0 days	N/A	Mar 25	N/A	N/A	N/A	N/A
Real Time Programming 4.5 days	Jan 22	Feb 5	N/A	Mar 4	N/A	N/A
Parallel Programming 4.5 days	Feb 12	Mar 11	N/A	N/A	N/A	N/A
ONYX Maintenance 10.0 days	Jan 29 Dec 11	Jan 15	N/A	Feb 5	N/A	N/A
WebFORCE Server Mgmt. 2.5 days	Feb 20	Feb 20	Jan 16	Feb 6	N/A	Feb 6 Mar 26
IRIS Performer 4.5 days	Jan 8	N/A	Jan 29	Feb 26	N/A	N/A
System Administration 5.X 4.5 days	Jan 22&29 Feb12&26 Mar11&25	Jan 22 Feb12 Mar 11	Jan 8 Feb 26 Apr 1	Jan 22 Mar 4 Mar 25	Jan 8&29	Jan 8 Feb 12 Mar 4
Network Administration 1 4.5 days Feb 5	Jan 8&22 Feb 5&26 Mar 11&18	Jan 29 Feb 26 Mar 18	Feb 12	Mar 11	Feb 5	N/A
Advanced System Administration 5.X 4.5 days	Jan 8&29 Feb 12 Mar 4	Jan 29 Mar 25	Feb 5 Mar 11	Jan 29 Mar 18	N/A	Jan 22 Mar 11
Open Inventor .5 days	Mar 25	Jan 8	N/A	N/A	N/A	N/A
ImageVision Library 2.0 days	Jan 16	N/A	N/A	N/A	N/A	N/A

KEY: LAEC–Los Angeles Education Center, L.A., CA.
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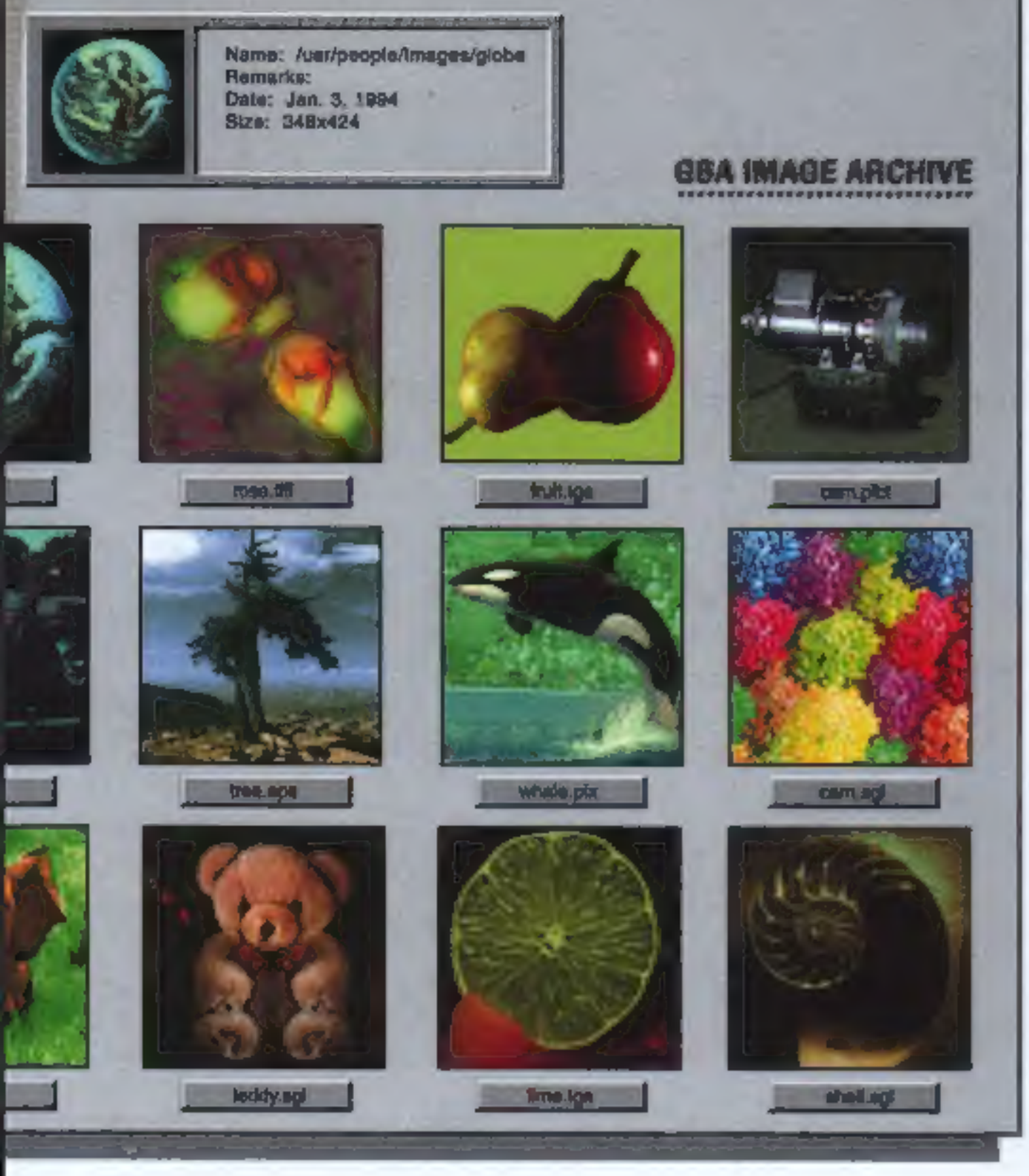

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